Major Rehabilitation Evaluation Report
And Environmental Assessment

Cape Cod Canal Highway Bridges
Bourne, Massachusetts

US ARMY CORPS
OF ENGINEERS
New England District

March 2020

This Page Intentionally Left Blank

Reverse of Front Cover

Front Cover Photograph: Looking Southwest through the Bourne Bridge to the Railroad Bridge at Buzzards Bay

Cape Cod Canal
Federal Navigation Project
Bourne, Massachusetts

Major Rehabilitation Evaluation Report
Cape Cod Canal Highway Bridges

March 2020

This Page Intentionally Left Blank

Reverse of Front Title Sheet

Cape Cod Canal Highway Bridges
Major Rehabilitation Evaluation Study
Executive Summary

This Major Rehabilitation Evaluation Report (MRER) presents the results of a study examining the relative merits of rehabilitating or replacing the two high-level highway bridges, the Bourne and Sagamore, which cross the Cape Cod Canal, and are part of the Cape Cod Canal Federal Navigation Project (FNP) operated and maintained by the U.S. Army Corps of Engineers (USACE), New England District (NAE). The USACE completes a MRER whenever infrastructure maintenance construction costs are expected to exceed $20 million and take more than two years of construction to complete. The MRER is a four-part evaluation: a structural engineering risk and reliability analysis of the current structures, cost engineering, economic analysis, and environmental evaluation of all feasible alternatives. The MRER is intended only as a means of determining the likely future course of action relative to rehabilitation or replacement. While conceptual plans were developed in order to facilitate the analysis no final determination has been made as to the final location or type of any new Canal crossings. Those would be determined in the next phase of the study and design effort.

Project Purpose and History

The Cape Cod Canal was constructed to provide coastwise shipping traffic with a more direct and safer route from northern New England ports to other areas on the U.S. eastern seaboard. The Canal allows vessels capable of navigating its 32-foot deep channel to avoid the much longer route around Cape Cod, or the even longer route around the islands and Nantucket Shoals. The Canal was originally constructed by the Boston, Cape Cod, and New York Canal Company (Canal Company) under a Charter issued by the Commonwealth of Massachusetts. The Charter required the Canal Company to build and operate two highway bridges and a railroad bridge over the Canal, which were built as low-level draw spans. Construction began in 1909 and the Canal was opened to marine traffic in 1914 and deepened to 25 feet in 1916. The Federal government took control of the Canal during World War I, along with other national transportation infrastructure, and operated the Canal through the 1920s.

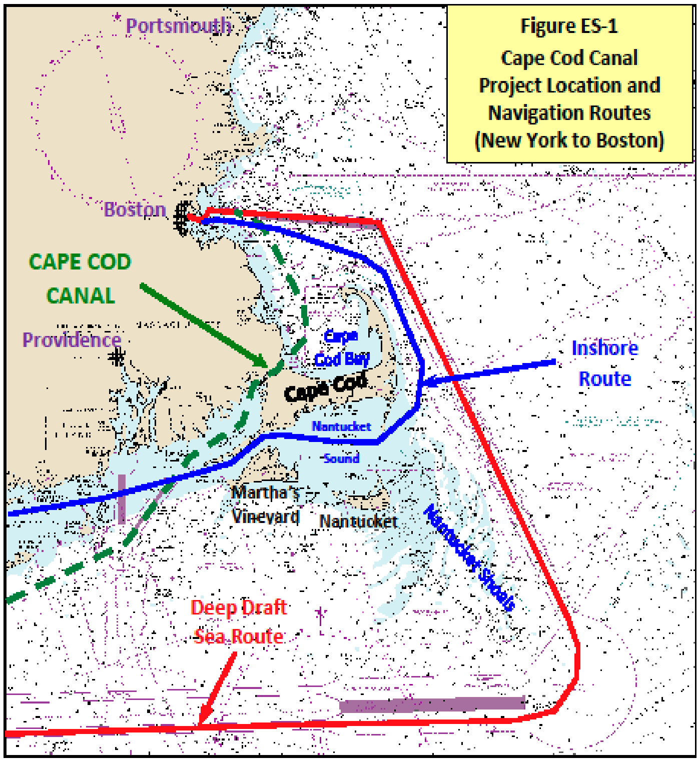


Figure ES-1
Cape Cod Canal
Project Location and
Navigation Routes
(New York to Boston)

The Canal was acquired by the Federal Government in 1928, and the USACE immediately began a program to re-establish the 25-foot channel depth. Under the authority of the National Industrial Recovery Act of June 1933 the Public Works Administration authorized the construction of three bridges over the canal, two highway and one railroad, in keeping with the terms of the original state charter. Work began to widen the channel through the land cut, clearing seaward approaches of obstructions, and provide bank stabilization, lighting and other improvements to navigation. The original plans for Canal deepening called for construction of locks, however this was abandoned in favor of a larger sea level canal after severe icing showed that locks would be impractical.

Work on the two new highway bridges and the railroad bridge began in December 1933, and the two highway bridges were completed in 1935. The Rivers and Harbors Act of August 30, 1935 authorized the USACE to assume maintenance of the three bridges. The 1935 Act also authorized further deepening and widening of the Canal to 32 feet MLW and 17.4 miles long, approach channels in Buzzards Bay 500 to 700 feet wide, with a bottom width of 540 feet in the land cut. That work was completed in 1940. Since that time the USACE has maintained the Canal, its channels, small boat basins, the railroad bridge and the two highway bridges at Federal expense. The bridge locations are shown in Figure ES-2.

The Canal remains an important waterway for coastwise traffic. In 2017 there were more than 21,000 vessel transits of the Canal, of which about 7,500 were ships of more than 65 feet in length. Cargo tonnage for 2016 was about 6.9 million tons. Auto carriers, cruise ships and military vessels are among the largest ships that use the Canal today.

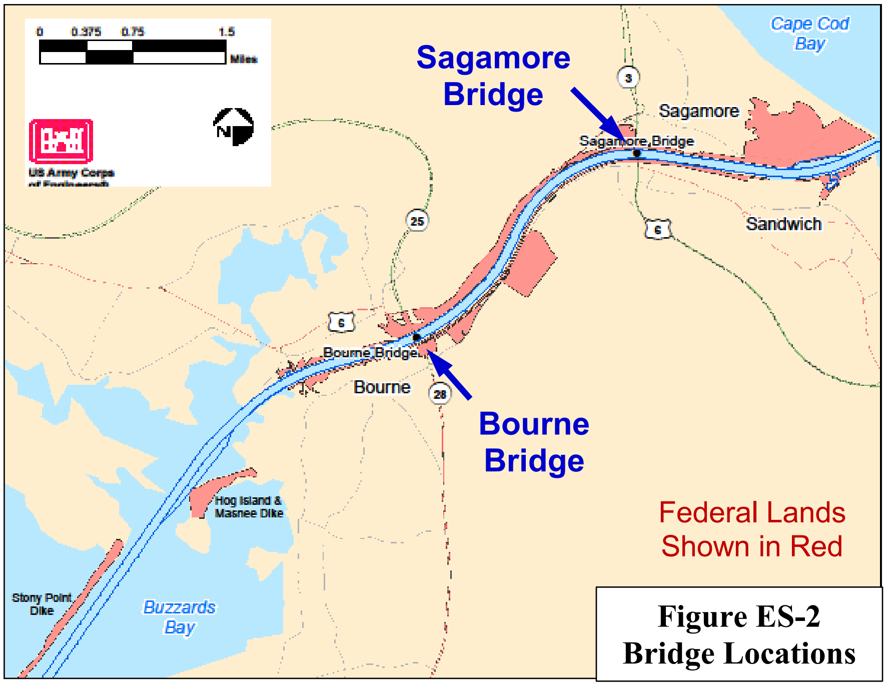


Figure ES-2
Bridge Locations

The two highway bridges are now 85 years old. Both bridges completed their first program of major rehabilitation in the early 1980s. As the bridges and their components continue to age, the cost of operation and maintenance and periodic rehabilitation slowly escalates. Both bridges are now scheduled to undergo their second major rehabilitation in 2025-2027 (Sagamore - $156.3 million) and 2029-2031 (Bourne - $186.2 million). These actions are expected to have impacts on transportation on and off the Cape and the Islands. Most passenger and vehicle traffic to the Islands must cross the Canal bridges to access the ferry terminals on the south shore of the Cape. Lengthy lane closures and full bridge closures would be necessary during the 3 to 7 years of major rehabilitation efforts. Closures of the Canal to marine traffic would also be necessary during some bridge work for the superstructure and deck. These closures would result in costs due to traffic delays, congestion and re-routing, in addition to the costs for bridge rehabilitation itself. Further another major rehabilitation of both bridges would be expected in the 2065-2069 timeframe.

The America's Water Infrastructure Act of 2018, Title I – Water Resources Development, provides additional authority for USACE replacement of the Cape Cod Canal highway bridges. Section 1315 of the act, *Corps of Engineers bridge repair program for New England evacuation routes,* states the following:

> *Subject to the availability of appropriations, the Secretary may repair or replace, as necessary, any bridge owned and operated by the Secretary that is –*
> *(1) located in any of the States of Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, or Vermont; and*
> *(2) necessary for evacuation during an extreme weather event, as determined by the Secretary.*

The Cape Cod Canal highway bridges are the only hurricane evacuation routes off Cape Cod and the Islands. They are the only highway bridges owned and operated by the USACE in New England and so are the only bridges to which this legislative language applies.

Given the high cost of major rehabilitation, the impacts expected to result from such actions, and the fact that major rehabilitation would not address the issues with current and anticipated traffic volumes, modern day highway and bridge design standards, and the escalating costs of normal maintenance and repairs, the USACE is conducting this MRER. The MRER will examine Major Rehabilitation and alternatives for constructing new Canal crossings. Rehabilitation and the alternatives will be measured against a common Base Condition of continued maintenance and repair of the bridges without major rehabilitation to determine the most cost-effective, safe and reliable means of providing vehicular crossing of the Canal. The location of the Canal and its sea routes are shown in Figure ES-1.

The Report

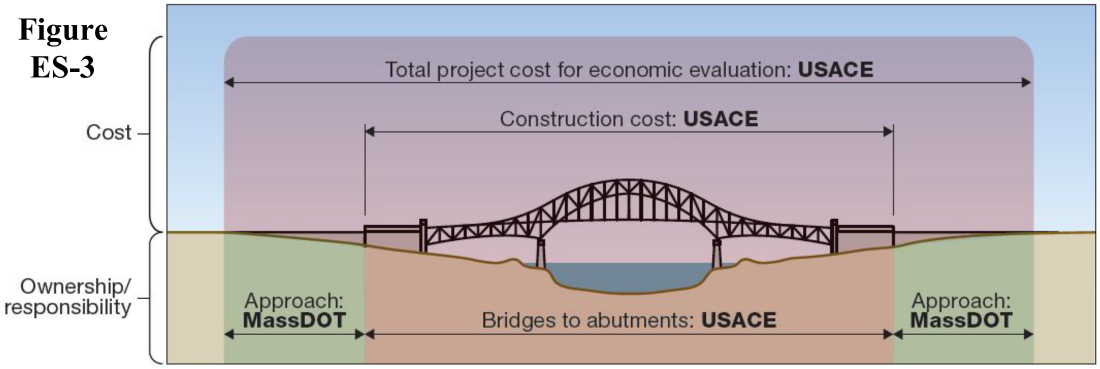
The documents provided include this MRER, and an accompanying Environmental Assessment (EA), necessary to make a risk informed decision, and several appendices providing greater detail on certain topics. A number of additional technical supporting documents (TSD), while not a part of the report, are included in the record as reference material. All studies and reports were prepared to the level of analysis required for identifying and evaluating conceptual alternatives with the goal of determining whether major rehabilitation or bridge replacement would provide the most cost effective, safe, efficient, and reliable means of providing long-term vehicular crossings of the Canal.

Sponsor and Jurisdiction

There is no non-Federal sponsor for the Cape Cod Canal Federal Navigation Project as a whole or for the two highway bridges. The Canal and its appurtenant features were purchased from a private corporation by the Federal government. The modified deep draft portions of the present Canal, the bridges and appurtenant structures were constructed at full

Federal expense without any non-Federal cost-sharing or partnership/cooperation agreements. Federal ownership of the two existing highway bridges covers the area between the shoreward abutments of both bridges as shown in Figure ES-3. Landward of the bridge abutments the Commonwealth (MassDOT) is the land owner and operates and maintains the highway approaches to the bridges.

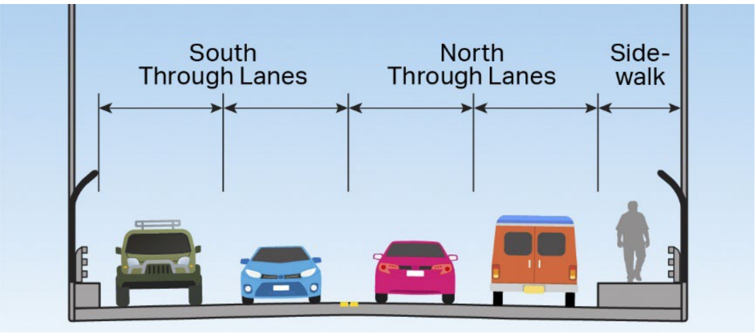
Figure ES-3


Cost
Ownership/ responsibility
Total project cost for economic evaluation: **USACE**
Construction cost: **USACE**
Approach: **MassDOT**
Bridges to abutments: **USACE**
Approach: **MassDOT**

Alternatives

The future of the Canal highway bridges has been the subject of public debate for several decades with a variety of solutions proposed at public meetings and in the press. Beyond the Base Condition limited to continued maintenance and repair of the bridges as needs arise (see Figure ES-4), a number of alternatives were initially examined and screened to yield a final set of plans for detailed analysis. The state and many local stakeholders have sought replacement of the bridges with more modern spans designed in accordance with current highway bridge standards for several decades. With a series of major maintenance and rehabilitation actions projected as necessary in the next ten years to assure safety and performance of the bridges it was decided to examine longer term bridge performance, benefits, costs, and impacts in the context of continued rehabilitation v. replacement. USACE regulation and policy require such projects be evaluated over a 50 year period of analysis.

Figure ES-4 – Deck Section for Existing Bridges



The existing Sagamore and Bourne Bridges have four 10-foot wide vehicle lanes and one combined pedestrian/bicycle lane. There are no shoulders or medians. The left-hand lane in each direction doubles as an auxiliary lanes for entering and exiting traffic.

Major rehabilitation of both bridges followed by additional maintenance, repair, and the next rehabilitation cycle was examined as an alternative. Additionally various methods for new crossings included new bridges, tunnels, causeways, low level v. high level bridges, and closure of the Canal and restoration of the pre-Canal road system. A list of these initial alternatives is provided in Table ES-1.

Table ES-1 – List of Alternatives

	Description	**Special Considerations**
Base A	Continued Maintenance and Repairs (Fix as Fails) of Both Existing Bridges as Needed to Maintain Safety. All alternatives are measured against this plan.	This is the Federal Base Plan – the Without Project Condition
B	A Program of Repairs and Major Rehabilitation for Both Bridges to Maintain Safety and Avoid Future Restrictions on Bridge Weight Postings	Major Rehabilitation of Each Bridge is Required about every 45 Years.
C	Replacement of One or Both Highway Bridges with New Bridges Each Limited to Four Widened Lanes, with Shoulders, Medians, and Sidewalks	Each Old Bridge would Remain in Service until the New Bridge was Completed
D	Replacement of One or Both Highway Bridges with New Bridges as in Plan C, but with Two Auxiliary Lanes Added	Each Old Bridge would Remain in Service until the New Bridge was Completed
E	Replacement of One or Both Highway Bridges with New Bridges with Additional (More than Four) Non-Federally Funded Through Traffic Lanes, plus Two Auxiliary Lanes	Each Old Bridge would Remain in Service until the New Bridge was Completed
F	Replacement of Both Highway Bridges with a Single New Bridge	Both Old Bridges would Remain in Service until the New Bridge was Completed
G	Non-USACE Construction of a New Third Highway Bridge	This would be a State implemented Alternative.
H	Replacement of One or Both Highway Bridges with Tunnels	Each Old Bridge would Remain in Service until the New Tunnel(s) were Completed
I	Replacement of Both Bridges with a Single Tunnel	
J	Replacement of One or Both High Level Bridges with Low Level Draw Spans	Each Old Bridge would Remain in Service until the New Bridge was Completed
K	Replacement of Both Bridges with Low Level Crossings on Causeways with Draw Spans for Shallow Draft Navigation	Both Old Bridges would Remain in Service until the New Causeway was Completed
L	Deauthorization and Closure of the Cape Cod Canal, Filling the Land Cut, and Restoration of Surface Highways, Drainage and Estuarine Ecosystems	Includes Retention of the Shallow Draft Harbors at Each End of the Canal (East Boat Basin, Buttermilk Bay and Onset Bay Projects

These initial alternatives were then evaluated and screened to reduce the list to only those plans which in terms of likely cost, impacts on the marine and land transportation systems, traffic and environmental impacts, and overall practicability would be implementable.

Alternative A, the Base Condition for continued maintenance and repair, was carried forward so as to provide a baseline against which the other alternatives could be measured. Alternative B, major rehabilitation of each bridge was also carried forward so that the ability to avoid the cost of replacement by extending the life of the bridges could be examined.

Alternatives (J, K and L) which involved closure of the Canal by filling, or construction of causeways or low-level fixed bridges or draw spans were eliminated from further consideration. Some of these plans would also constrain navigability or eliminate the Canal as a shallow draft waterway. These alternatives would degrade the efficiency and safety of coastwise navigation as some or all of the Canal's marine traffic would be diverted to the Atlantic shipping routes to the south and east of the Cape, Islands, and Nantucket Shoals. Increased risk and cost to shipper, fishermen and boaters would all result from any of these three plans. Restricting or closing the Canal to navigation would be inconsistent with the Congressional authorization for the Canal as a deep-draft waterway and would require legislation to implement.

Plans involving tunnels (Alternatives H and I) were eliminated from detailed analysis based on high costs and extensive impacts on the environment and land uses. An examination of recent tunnel projects elsewhere on the east coast indicated that tunnels as new Canal crossings, whether trenching for immersed tubes or much longer and deeper bored tubes, would carry at least twice the cost of new bridges.

Construction of a new single bridge (Alternative F) or additional "third" bridge (Alternative G) were also eliminated based on cost and impact. A single bridge as replacement of the two existing bridges would require extensive relocation and realignment of the state and local road systems to change the approaches on both sides of the Canal to align with the new crossings. Extensive and costly real estate takings would be required. Impacts to natural resources including wetlands, agricultural lands, homes and businesses would occur. Overall a third or single bridge was not considered practicable.

Provision of two new bridges to replace the existing bridges, but with the deck of each bridge limited to carrying two lanes in each direction (Alternative C - in other words without auxiliary lanes) was also eliminated from detailed consideration based on comments received during review of the draft report. While such a design is within the Corps existing authority to provide vehicular crossings over the Cape Cod Canal, a design that eliminates auxiliary lanes in this situation would not be consistent with modern highway design under FHWA design standards and MA DOT guidelines. Carrying this alternative forward for detailed consideration would therefore be contrary to best engineering practices. This alternative was therefore not carried forward for detailed study in the final report.

Replacement of the two bridges with new bridges carrying additional through-traffic lanes (Alternative E) was also eliminated. While auxiliary lanes for acceleration/deceleration to improve safety and efficiency of entrance and access to the bridges from the local area could be included, additional through-traffic lanes would not be in accordance with the existing authority of the Federal government for the Cape Cod Canal navigation project. New Federal legislation would be required for any expansion of capacity to be implemented. Additional through traffic lanes would not generate appreciable benefits to traffic without extensive state improvements to region's highway capacity on both side of the Canal, which would carry high costs and greater impact to the environment and the communities. Further the state has indicated it would not support state-funded additional through traffic lanes for the bridges as this would also require more extensive improvements, including adding lanes, to the regional highway network to yield any benefit. This plan was therefore eliminated from further consideration.

Provision of two new bridges to replace the existing bridges with auxiliary lanes included on the bridge decks was carried forward for detailed analysis (Alternative D). Provision of two replacement bridges at Bourne and Sagamore, each with two through travel lanes and one auxiliary lane in each direction, is within the Corps existing authority to provide vehicular crossings over the Cape Cod Canal, and no additional authorizing legislation would be required. Provision of auxiliary lanes in addition to two through traffic lanes conforms to FHWA and MA DOT design guidelines and would address issues with traffic safety. Other than modifications and realignment of approach roads no more extensive state improvements to the regional highway system would be required. MassDOT's plans for eliminating bottlenecks in the vicinity of the bridges with improvements to adjacent supporting state highway infrastructure are discussed in their 2019 Cape Cod Regional Transportation Study. Impacts from bridge and supporting state highway construction would be minimized by locating new bridges in close proximity to the existing bridges. This alternative was therefore carried forward for detailed analysis.

Detailed Plans

Three alternatives were carried forward for development and evaluation of detailed plans. These included Plan A – the Base Condition for continued maintenance and repair as needed; Plan B – major rehabilitation of both existing bridges followed by regular maintenance, repair and eventually another rehabilitation action with the 50-year period of analysis; and Plan D – Bridge Replacement for both bridges with 6 vehicle lanes.

Table ES-2 – List of Alternative Plans Carried Forward for Detailed Analysis

Plan	Description	Special Considerations
Base A	Continued Maintenance and Repairs to Both Existing Bridges as Needed to Maintain Safety (Fix as Fails)	This is the Federal Base Plan – the Without-Project Condition or the No Action Plan
B	A Program of Repairs and Major Rehabilitation for Both Bridges to Maintain Safety and Avoid Future Restrictions on Bridge Weight Postings	Major Rehabilitation of Each Bridge is Required about every 45 Years.
D	Replacement of One or Both Highway Bridges with New Bridges having Four Through-Traffic Lanes and Two Acceleration/Deceleration Lanes	Each Old Bridge would Remain in Service until the New Bridge was Completed

Engineering Reliability

An engineering analysis was performed to demonstrate the reliability of major components of the Bourne and Sagamore bridges. The major components of the bridges are the substructure (piers and abutments), the superstructure (largely the steel trusses supporting the deck and attaching to the substructure), and the deck itself. The results of this analysis forms the basis for the economic evaluation of the base condition versus plans for repair or replacement.

A timeline of anticipated component failures was developed along with a schedule of likely repairs and costs. The history of bridge repairs and rehabilitation, condition ratings, performance/deterioration models, and fatigue and corrosion analyses are all used to establish projected reliability of the components. Reliability is defined as the probability that unsatisfactory performance will not occur. Reliability calculations were prepared for each component for each year of the 50-year analysis period. For this study, the limit state for unsatisfactory performance is defined by the physical condition of the bridge's major components. This "limit state" is the point at which either unsatisfactory performance will occur or the engineering consequences will have some adverse economic impact.

Unsatisfactory performance of one or more of these critical elements would lead to unsatisfactory performance of the entire bridge. In order to assess the engineering reliability of the bridges, a probabilistic hazard function was developed for each of the three critical elements. For each major component, a probability distribution was developed to predict deteriorating bridge element performance over a fifty-year service life. The consequences of unsatisfactory performance are presented on an event tree for each critical element under each economic alternative.

Potential repair actions that would likely be necessary over the 50-year period of analysis are added to event trees, costs for each action are estimated, and statistical analysis is employed to weight those costs in terms of the likelihood of required actions to maintain bridge performance. Component failures and repair actions to address them will also have impacts on vehicular and marine traffic in terms of transportation delays. Lane and bridge closure results in transportation cost increases from delays and diversion of traffic. Total cost is the adjusted construction cost for repairs plus the transportation delay costs incurred by users of the bridges, all resulting from the reliability analysis.

Analysis of Detailed Plans

The Base Condition (Plan A) and the two plans carried forward for detailed analysis (Plan B – Major Rehabilitation and Plan D – Bridge Replacement) are discussed below. All costs and benefits are provided in FY20 price levels. Cost estimates prepared at this phase were developed at a conceptual level to compare rehabilitation vs. replacement and are not intended for budgeting purposes.

Plan A – the Base Condition was developed using the engineering reliability analysis as described above. Regular maintenance would continue and repairs to bridge components would be made as needed. Possible repairs cover a wide range of possibilities from deck resurfacing to emergency bridge replacement due to failure of critical components. Increased transportation costs include the potential for future posting of weight restrictions on the bridges. The cost of making repairs on an as needed or emergency basis and the cost of transportation delays (traffic and marine) are summed to arrive at total costs for this plan. These costs are then evaluated using probabilistic simulations that are described below in the economic analysis. The results serve as the baseline for measuring the costs and benefits of the other detailed plans.

Plan B – Major Rehabilitation of the existing bridges required a similar analysis of anticipated reliability and performance over time. Costs and schedules for the rehabilitation actions were identified along with those for post rehabilitation repairs and the next cycle of rehabilitation which would occur before the end of the 50-year period of analysis. The future costs were then reduced to their present worth. Major rehabilitation would also have impacts on transportation delays and costs. The construction cost for major rehabilitation and major repairs over the 50-year period of analysis is shown in Table ES-3. Bridge and lane closure days for the initial major rehabilitation action are shown in Table ES-4.

Table ES-3
Major Rehabilitation Costs – Bourne and Sagamore Bridges

Item/Component and FY 2020 Costs (October 2019 Price Levels)	Bourne Bridge 2029-2031	Sagamore Bridge 2025-2027
Total Major Rehabilitation Cost	$186,171,000	$156,301,000
Maintenance – Complete Painting (2049/45)	$26,827,000	$33,425,000
Third Major Rehabilitation Bourne 2069 – Sagamore 2065	$132,120,000	$110,940,000
Total Rehabilitation and Major Repairs	$345,118,000	$300,666,000
Note: Updated March 2020 - Does not include annual maintenance and minor repairs		

TABLE ES-4
Anticipated Traffic Management for Lane and Bridge Closures
With Major Rehabilitation 2025-2031

Major Rehabilitation Activity	Bourne Bridge	Sagamore Bridge
Total Days of Lane Closures	480	380
Total Days of Full Bridge Closures	180	130

Plan D - Bridge Replacement includes higher up-front costs for construction, but has far lower costs for maintenance and repair over the 50-year period of analysis. The bridge replacements also would have far fewer impacts on transportation costs as maintenance, repair and future rehabilitation would be limited. The existing bridges would remain in service while the new bridges were built and the new bridge construction would have minimal impacts on adjacent roads. There would be some temporary impacts to marine transportation through the Canal during new bridge construction, but less impacts over time. State construction of realigned approach roads would have an impact on land transportation costs.

The conceptual design chosen for evaluation of new bridges at this phase of the analysis used a cable-stay design for both replacement bridges. This conceptual design included consideration of sea level change, reduced deck grades, wider traffic lanes, shoulders, medians, and bicycle/pedestrian walkways. The location and alignment of any new bridges would be determined during the next phase of investigation and design. For this level of analysis it was assumed that the new bridges would be built adjacent to the existing bridges. The area for potential siting for the replacement bridges is shown in Figure ES-5.

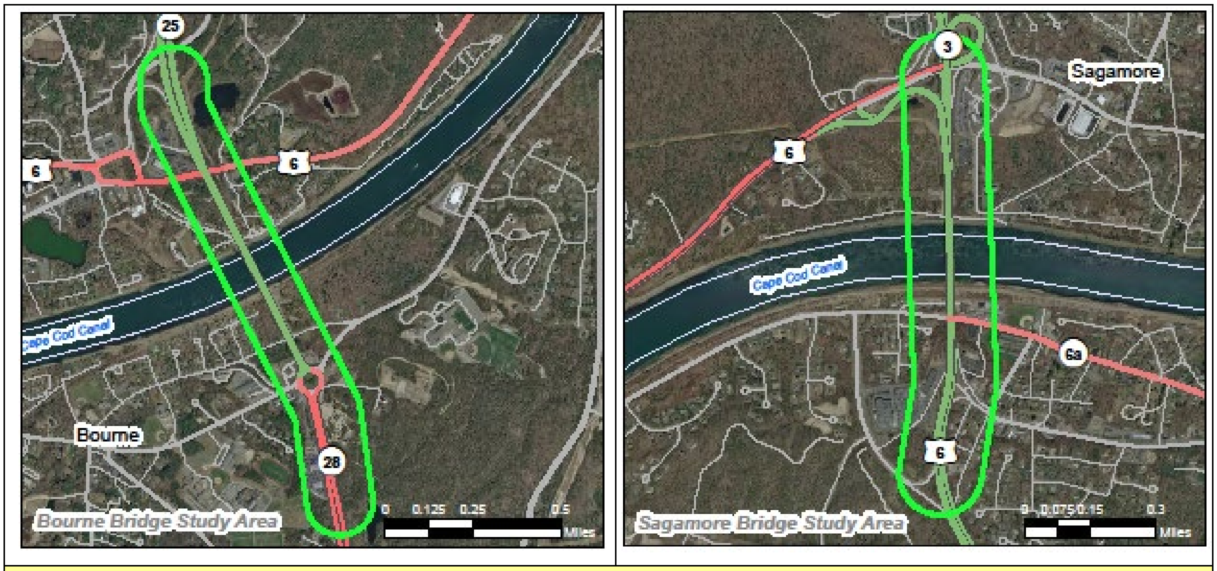


Figure ES-5 – Concept Level Siting Areas for Replacement Bridges

Plan D also consists of replacement of the two highway bridges each with six lanes (two through travel lanes plus one auxiliary lane in each direction). The additional auxiliary lanes for exit and entrance would address traffic safety concerns by allowing for two unobstructed through travel lanes each way. Vehicles in the right-hand travel lane in each direction would not be slowed by merging and decelerating traffic on the bridges. This plan also considered sea level rise, reduced bridge deck grades, and other improved design elements including shoulders, medians, and pedestrian/bicycle lanes separated from the vehicle lanes. The estimated cost for each bridge under Plan D is shown below in Table ES-5.

Table ES-5
Project Costs – Bridge Replacement Alternatives – Plan D

Cost Category ($000s) FY 2020 Price Levels	Bourne Bridge	Sagamore Bridge
Construction Cost	$355,478	$232,630
Contingency Cost (44%)	$156,410	$102,357
Planning, Engineering & Design	$40,951	$27,321
Construction Management	$14,199	$9,594
Total Construction	$567,038	$371,902
Cultural Resource Preservation	$29,450	$19,241
Lands, Easements, ROW	$7,645	$7,618
Utility Relocations	$26,640	$29,520
Total Federal Project Cost	$630,773	$428,281

Table ES-5 (Continued) – Costs	Bourne Bridge	Sagamore Bridge
Associated Non-Federal Highway/Roadway Modifications		
State-Funded Bridge Approaches	$90,991	$57,802
Anticipated Future Major Repair Actions for New Bridges (Bourne/Sagamore)		
Major Repairs #1 (2054/2049)	$7,911	$7,906
Major Repairs #2 (None/2069)	- - -	$7,906
Total Project Cost (50 Years)	$729,675	$501,895
Note: Estimate Revised March 2020		

Economic Analysis

As part of this MRER, an economic evaluation was performed to analyze the costs and benefits of the Base Condition and compare it to alternatives, including major rehabilitation and bridge replacement. Costs and benefits are in FY20 price levels. The Base Condition refers to a baseline of continued regular inspections and standard maintenance construction on the bridges. The economic analysis is extended over a 50-year period using 2020 as the base year and the Federal Discount Rate currently set at 2.75 percent for Federal Fiscal Year 2020. Below is a brief summary of the findings of the economic analysis.

The economic analysis focused on the base plan and the two detailed plans described above:

1. Alternative A: Base Condition (Without-Project)
2. Alternative B: Major Rehabilitation of both Existing Bridges
3. Alternative D: Replacement with Two 4-Lane Bridges with Auxiliary on/off Lanes

Annual benefits considered for each alternative include the reduction in emergency repair spending, the decrease in traffic delays, and changes in cost to waterway navigation. The annual benefit of each alternative is then compared to its respective cost. An alternative is considered economically justified if it maximizes net annual benefits and its benefit cost ratio (annual benefit divided by annual cost) is greater than one.

The analysis is performed using a risk based approach to compare costs and benefits of each alternative to the Base Condition. Reliability functions from the engineering event trees are utilized to simulate possible component failures and associated repair costs. The three engineering components that could experience failure are the *bridge deck, substructure,* and *superstructure*. This analysis is evaluated over a 50-year period using Monte Carlo Simulation to determine the likely long-term costs of the future Base Condition without the project and the future condition with each alternative. The model was approved for single-use by the USACE Planning Center of Expertise for Inland Navigation and Risk Informed Economics Division in July 2018. The memo documenting this approval pursuant to EC 1105-2-412 is attached as an addendum to Appendix D - Economics.

The overall cost of each alternative includes several elements; the cost of the repair itself, the economic cost to vessels that cannot use the canal (navigation costs), operation & maintenance costs, and the change in value of time incurred by drivers in traffic delays (travel costs) during lane and bridge closures for repairs or construction phases.

The value of time is determined using USACE regulation (ER 1105-2-100). Traffic data was modeled by TrafInfo; a transportation consulting company familiar with the Massachusetts Department of Transportation (MassDOT) data. TrafInfo provided Cape Cod traffic study data and forecasts. This traffic data was used to determine the total hours of traffic delay incurred during construction for all travelers crossing the bridges. A monetary value was attributed to these lost productive hours using the average hourly household median income of the surrounding towns as sourced from the US Census Bureau.

A comparison of mean annual costs for the base condition and two detailed plans is provided in Table ES-6 below. These costs represent the economic impacts of unscheduled component failures and unscheduled maintenance events that will occur over the 50 year period of analysis. Maintaining the bridges in the current, base condition would result in annual repair and transportation costs of $123.9 million and $65.2 million for the Sagamore and Bourne Bridges respectively. Under the Major Rehabilitation scenario, those expenses would decrease to $8.8 million for the Sagamore Bridge and $6.1 million for the Bourne Bridge. Replacing the bridges reduces the annual costs for the Sagamore Bridge even further to approximately $4.5 million. Costs for the Bourne Bridge increase slightly to $7 million.

Table ES-6
Mean Annual Costs for All Plans
Results from Monte Carlo Simulations ($000)

FY2020 Price Levels	**Repair Cost**	**Travel Cost**	**Navigation Cost**	**O&M Cost**	**Total**
Plan A – Base Condition					
Sagamore	2,800	120,700	1	400	123,900
Bourne	3,200	61,700	1	300	65,200
Plan B – Major Rehabilitation					
Sagamore	300	0.6	8,000	400	8,800
Bourne	400	0.6	5,400	300	6,100
Plan D – Bridge Replacement – 4 Lanes plus Auxiliary Lanes					
Sagamore	300	0.1	4,000	200	4,500
Bourne	500	0.2	6,300	200	7,000

Tables ES-7 provides summary detail of all annual costs, benefits, and benefit to cost ratios (BCRs) for the major rehabilitation and bridge replacement plans.

Table ES-7 – Comparison of Rehabilitation and Replacement Plans

FY 2020 Price Levels ($000s) Revised February 2020	Plan B - Major Rehabilitation	Plan D – Bridge Replacement
Sagamore Bridge		
Total Federal First Cost	$156,300	$428,300
Future Federal OMR&R	$144,400	$15,800
State-Funded Approaches	- - -	$57,800
Travel Delay Costs	$1,281,000	$92,800
Total – Sagamore	$1,581,700	$594,700
Total Cost Discounted + IDC	$969,500	$469,000
Total Annual Cost – 2-3/4%	$35,600	$17,400
Discounted Cost – Base Plan	$123,900	$123,900
Discounted Cost – Plan B & D	$8,800	$4,400
Total Annual Benefits	$115,100	$119,500
Annual Net Benefits	$79,200	$102,100
Benefit-Cost Ratio	3.2	6.9
Bourne Bridge		
Total Federal First Cost	$186,200	$630,800
Future Federal OMR&R	$158,900	$7,900
State-Funded Approaches	- - -	$91,000
Travel Delay Costs	$948,300	$22,400
Total – Bourne	$1,293,500	$752,100
Total Cost Discounted + IDC	$731,100	$574,400
Total Annual Cost – 2-3/4%	$27,100	$21,300
Discounted Cost – Base Plan	$65,200	$65,200
Discounted Cost – Plan B & D	$6,100	$7,000
Total Annual Benefits	$59,100	$58,300
Annual Net Benefits	$32,000	$37,000
Benefit-Cost Ratio	2.2	2.7

Based on Net Benefits, the rank of alternatives (with 1 being the most desirable) is:

1. Alternative D: Replacement with two 4-lane bridges with auxiliary on/off lanes
2. Alternative B: Major rehabilitation of existing bridges
3. Alternative A: Base Condition - continue to maintain the bridges with regularly scheduled maintenance and make emergency funding available when there is a component failure to repair the failure.

The economic analysis suggests that fixing the current bridges as components deteriorate will lead to greatly increased costs, particularly costs for travelers delayed in traffic.

Major rehabilitation of the existing bridges demonstrated positive net benefits and a benefit-cost-ratio (BCR) of 3.2 for the Sagamore Bridge and 2.2 for the Bourne Bridge. One advantage of the rehabilitation is a lower initial construction cost for the project when compared to replacing the bridges. The disadvantages are the impact it will have on traffic patterns during the time of construction due to lane and full bridge closures as well as the bridges not being brought up to current engineering standards and regulations.

The alternative for replacement bridges (two 4-lane bridges with auxiliary lanes) had higher net benefits and BCRs than the rehabilitation scenario. One disadvantage of the new bridges is the high initial cost of construction. On the other hand, advantages of the replacement bridges are minimal disturbances to traffic during construction and replacing the aging infrastructure with bridges at current engineering standards and regulations. Bridges with auxiliary lanes would also result in less traffic delays during minor repairs and inspections as two lanes in each direction could remain open in many circumstances.

The analysis suggests that the two replacement bridges are more economically justifiable given the lower costs. However, it is important to note that this analysis was performed under the assumption that the infrastructure and surrounding roadways to the bridges remain in their current conditions and are not upgraded by the Commonwealth of Massachusetts. If the state choses to improve the road network surrounding the bridges, particularly near the Bourne Rotary, then bridge replacement will provide additional benefits to improved travel time that could increase the net benefits and BCRs. The bridges with four through traffic lanes and two auxiliary lanes can also reduce the impact to the traveling public when performing future maintenance on the bridges.

Environmental Impact Analysis

Environmental conditions and impacts have been evaluated in the Environmental Assessment based on a conceptual bridge design. Resources and potential impacts will be more fully defined and analyzed when the project moves to the design phase. Considerations examined included land uses, geography and geology, climate, air quality, contaminants wetlands, water resources, water quality, terrestrial and marine wildlife, fisheries, threatened and endangered species, environmental justice, and other areas of concern. Removal of the existing bridge once any new bridges are placed in service was also considered with respect to impacts from demolition. Indirect impacts such as local traffic conditions, induced development potential, and population changes were considered. Cumulative impacts from state highway improvement and other proposed development projects were also considered.

This study and preparation of the documents has followed USACE regulations and policy for MRERs and the NEPA process. Five agencies were invited to participate as cooperating agencies for the MRER: MassDOT, Federal Highway Administration (FHWA), U.S. Coast Guard, Environmental Protection Agency (EPA), and National Marine Fisheries Service (NMFS), and all agencies accepted. Representatives from Federal, state, and local agencies, and federally-recognized Tribes with interest or jurisdiction in the proposed project were invited to a scoping meeting and coordinated site visit on March 19, 2019.

Early coordination was also conducted with several resource agencies including: U.S. Fish and Wildlife Service, National Marine Fisheries Services, MA Office of Coastal Zone Management, and MA Historic Preservation Office to discuss project plan formulation and consider potential impacts to specific resources and agency comments and concerns. Further consultations will continue during Phase II of the project with these and additional agencies and interests.

Public involvement at this stage consists of public meetings held at the beginning and end of the study process, receipt and consideration of public input throughout the process, and public review and comment on the draft MRER and EA before reports are finalized and any decisions are made.

During the next phase of investigations additional studies will be performed in a more focused effort as plans for bridge location and alignment, and associated state sponsored improvements are more fully designed and considered.

Cultural Resource Concerns

Section 106 of the National Historic Preservation Act (NHPA) requires that a federal agency take into account the effects of an undertaking on historic properties. In the study area, there are three historic period resources, the Bourne and Sagamore bridges, and the canal. There are no identified archaeological resources in the vicinity of the Sagamore Bridge study area. There are two archaeological sites within the vicinity of the Bourne Bridge. The Base Condition and Major Rehabilitation would have little to no impact on cultural resources. Impacts from construction of replacement bridges will depend on final locations and their proximity to any known resources or resources identified during the next phase of the project. Additional cultural resource survey will be required to determine the extent and nature of any impacts and the appropriate response. Construction of new bridges will include demolition and removal of the existing bridges. Compliance with the NHPA will require preparation and execution of a Memorandum of Agreement to avoid, minimize, or mitigate effects to historic properties.

Cultural resources coordination was initiated with the State Historic Preservation Officer (SHPO), Tribal Historic Preservation Officers (THPOs) of the Mashpee Wampanoag and the Wampanoag Tribe of Gay Head (Aquinnah), and the Historic Commissions of the Towns of Bourne and Sandwich. Additional consultation with these agencies on the location of the bridges and the bridge design would be required during the next phase of the project.

Real Estate Considerations

Neither the Base Condition nor Major Rehabilitation would require additional lands, easements or rights of way. Bridge Replacement would require acquisition of new lands by the Federal government for the new bridge footprints. The state may also need to acquire new lands for modified approach and connecting roads. While final location and alignment of the two new bridges would be determined during the next phase of investigation and design, for the purposes of this analysis it was assumed that the new bridges would each be located next to and inland of the existing bridges. This location would minimize land takings as existing

Federal and state properties would be used for much of the footprints and local connecting and state approach roads would require minimal realignment.

At this level of analysis it was estimated that replacement of the Bourne Bridge would require acquisition of about 11 acres of land and their improvements and relocation of businesses, all totaling about $7.6 million. A new Sagamore Bridge would require about 4.5 acres of new land plus improvements and relocations also totaling about $7.6 million.

Major Rehabilitation and Bridge Replacement would require utility relocations including electrical power and telecommunications cables and several natural gas transmission lines, all of which are beneath the current bridge decks. Full deck replacement and some major steel repairs would require removal of these utilities. Utility cables could be moved to the new bridges once they were completed. Gas lines crossing the bridges would need to be relocated. Utility relocation costs are estimated to vary from $56.9 million for replacement to $25.5 million for rehabilitation. These utility costs were based on the number of crossings and similar replacement costs on recent projects in the region. Discussions with utility owners and operators have begun and will continue into and throughout the design phase of the project. As final bridge location, alignment, type, and need for state connecting road improvements become better defined utility needs will also refined. Specific utility costs, and the allocation of those costs between the utility owners and the Government, will be developed during the design phase in consultation with the utility owners and the state.

Other Social Effects

The Bourne and Sagamore bridges provide the only vehicular access to the 15 towns of Cape Cod with nearly 215,000 year-round residents and a population increase of up to 300 percent during the height of the summer tourist season between Memorial Day and Labor Day. The bridges also provide access to the eight offshore island municipalities through the ferry terminals located on the south shore of Cape Cod. Traffic volumes have increased exponentially since the 1930's leading to significantly increased loading on the bridges with the result of increasingly frequent maintenance and repair events.

Frequent lane closures, coupled with the lack of auxiliary lanes, mean that for much of the time there is only one through traffic lane in each direction on both bridges. Backups for travelers waiting to cross the bridges commonly stretch for several miles, particularly on late spring through early fall weekends when vacationers crowd the Cape and Islands. The extent of traffic delays is a source of frustration for many residents and visitors, especially as summer tourism brings significant income to area residents and businesses.

Conclusions

The objective of the MRER is to identify the plans that most efficiently and effectively meets the long-term requirement for the Federal Government to provide, operate, maintain, repair, rehabilitate, and replace (OMRR&R) crossings of the Cape Cod Canal for vehicles, pedestrians and other surface traffic. Engineering reliability of the structures, when analyzed together with cost and economic benefits form the basis of the analysis and determine the recommended plan.

In conducting this study the following tasks were performed: (i) the deficiencies of the components of the two existing highway bridges (Sagamore and Bourne Bridges) were identified, (ii) their reliability indices were estimated, (iii) impacts to road traffic and marine traffic from component failure were estimated, (iv) the increases in reliability based on each improvement alternative were estimated, (v) economic benefits were estimated, and (vi) costs to repair deficient components or replace the bridges were estimated. All of these tasks provided inputs to the economic evaluation of alternatives. Increases in reliability, with respect to the costs to attain them, in order to continue safe and reliable navigation and highway access, was the ultimate objective of this evaluation.

The cost estimates presented in this report were developed based on concept level plans and are not adequate for use in budgeting for implementation. Cost certification at this phase is conditional due to the limited scope of the analysis. The next phase of the project will include more detailed investigations, final bridge locations and designs, and more detailed and refined cost estimates.

The cost of repairs or rehabilitation are only part of the analysis. The total economic impact to travelers from lane, bridge and waterway closures during the major rehabilitation of the Sagamore Bridge is estimated to be \$782.6 million and \$536.7 million (discounted delay cost) for the Bourne Bridge Rehabilitation project. Total transportation delay costs over the 50-year period with the major rehabilitation plan (B) would be \$1,281.3 million for the Sagamore and \$948.4 million for the Bourne. In contrast the 50-year costs for construction for the rehabilitation plan are \$300.7 million for the Sagamore and \$501.9 million for the Bourne. The bulk of the cost impact for the rehabilitation plan will fall on the travelling public, about 83% of the cost for the Sagamore and 78% of the cost for the Bourne.

The bridge replacement alternative (Plan D) had higher net benefits and a higher BCR than the major rehabilitation plan. The disadvantage of the replacement bridges is the high initial cost of construction. The advantages of the replacement bridges are minimal disturbances to traffic during construction and replacing the aging infrastructure with bridges that meet modern engineering standards and regulations. The new bridges would not require the level of frequent, costly, and escalating maintenance and repairs, or entail the high level of disruption to traffic and the economy of the region.

It is important to note that this analysis was performed under the assumption that the road infrastructure surrounding the bridges are in their current conditions and are not upgraded by the Commonwealth of Massachusetts. If the state choses to improve the road network surrounding the bridges as suggested in the draft Cape Cod Transportation Study, particularly near the Bourne Rotary and the improvements to Route 6, then the replacement bridges will provide additional efficiency benefits of improved travel time by allowing the left-hand travel lanes to be fully used by through traffic, since exiting and entering traffic would use the auxiliary lanes. Shifting the exiting and entering traffic out of the right-hand through traffic lanes will also have benefits to traffic safety as conflicts between fast-moving and slow moving vehicles will be minimized.

New replacement bridges would have significantly higher reliability and lower probability of failure than the existing bridges would have moving forward with the rehabilitation plan. The distribution of costs for the replacement is nearly the reverse of that for the rehabilitation plans. Transportation delay costs to the public and users of the Canal with bridge replacement account for only about 16% of total costs for the Sagamore and 3% of total costs for the Bourne. This compares to 81% and 73%, respectively for each bridge under the rehabilitation plan. Moving from rehabilitation to replacement shifts the cost burden from the public (delay costs), to the Government (construction and repair costs). The calculations for cost distribution are provided in Table ES-8.

Table ES-8 – Cost Distribution Comparison
Plan B Bridge Rehabilitation v. Plan D Bridge Replacement

FY20 Price Levels Revised Feb 2020	**Rehabilitation**	**Replacement**
Sagamore Bridge		
Repair/Replace Costs	$300,700	$501,900
Delay Costs	$1,281,300	$92,800
Total Costs	$1,582,000	$594,700
Repair as %	19.0%	84.4%
Delay as %	81.0%	15.6%
Bourne Bridge		
Repair/Replace Costs	$345,100	$729,700
Delay Costs	$948,400	$22,400
Total Costs	$1,293,500	$752,100
Repair as %	26.7%	97.0%
Delay as %	73.3%	3.0%

The two existing bridges are now coming up on their second major rehabilitation. The rehabilitation of the Sagamore Bridge would be scheduled for 2025-2027 and cost about $156.3 million (FY20), or $188.8 fully funded (through the midpoint of construction). The rehabilitation work on the Bourne Bridge would be carried out in 2029-2031 at a cost of about $186.2 million (FY20), or a fully-funded cost of about $252.1 million. During these periods the work would require a total of about 760 days (or more than 2 years) of lane closures and 310 days (or more than 10 months) of full bridge closures, with consequences to traffic and the local economy.

A program of critical repairs may be able to delay the full rehabilitation starts by a several years, but if bridge replacement is approved any delay in implementing that work would require rehabilitation to proceed. In other words, any appreciable delay in decision-making or funding could force the Government to pursue major rehabilitation instead of bridge replacement in order to maintain reliability and safety of vehicular traffic over the Canal in the near term.

The Commonwealth of Massachusetts would be a necessary partner in any rehabilitation or replacement project. However the State's principal role would involve redesign and relocation of connecting highways and roadways if bridge replacement is pursued. The State has made a capital investment of $10 million dollars to begin environmental coordination and early design work for adjacent infrastructure and new bridge approaches in 2020. In addition, the Commonwealth has proposed more than $350 million in future infrastructure funds in their 2019 Transportation Bond Bill for work in the coming years. The work needed includes study, design and construction of transportation infrastructure associated with the approaches to the Bourne and Sagamore Bridge as a part of the Cape Cod Bridges Improvement Program within the *Act Authorizing and Accelerating Transportation Investment*, Section 2A, 6121-2147. Any delays in Federal funding could put that commitment and associated work in question.

There is a level of urgency in Federal and State decision making concerning the recommendation and funding to implement the design and construction of new bridges. Approval of this report and its recommendation for two replacement bridges to include auxiliary lanes (Plan D) would allow the USACE to proceed with the next phase of the process – the identification of the final replacement bridge location, alignment, size and type, complete Federal, State and local regulatory coordination, including conclusion of the NEPA process, and initiate final design.

The Recommended Plan

This study has determined that providing two new highway bridges would be the most cost effective means of providing safe and reliable crossings. The existing bridges are 85 years old and both are functionally obsolete. The Bourne Bridge is also classified as structurally deficient under current Federal Highway Administration guidance.

Conceptual designs for two replacement bridges have been developed to facilitate this analysis and recommendation. Specific design features would be developed in the following phase of implementing this project. For purposes of this level of analysis it was assumed that a new high level fixed span bridge would be constructed immediately adjacent to each of the two existing highway bridges so as to minimize the modifications needed to the connecting roadways on both the mainland and the Cape. The new highway bridges would be designed to include access for both pedestrians and other non-vehicular traffic such as bicycles. To improve traffic safety and through traffic reliability each bridge would include one acceleration/deceleration lane and two through traffic lanes in each direction, for a total of six vehicular lanes on each bridge.

The two existing bridges would remain in in operation until the new bridges are opened to traffic. The fate of the two existing bridges will be determined in the detailed design phase, but for now it is assumed that they would be closed to traffic and demolished once the new bridges are opened. The USACE would need to determine the scrap value of the existing bridges during the detailed design phase.

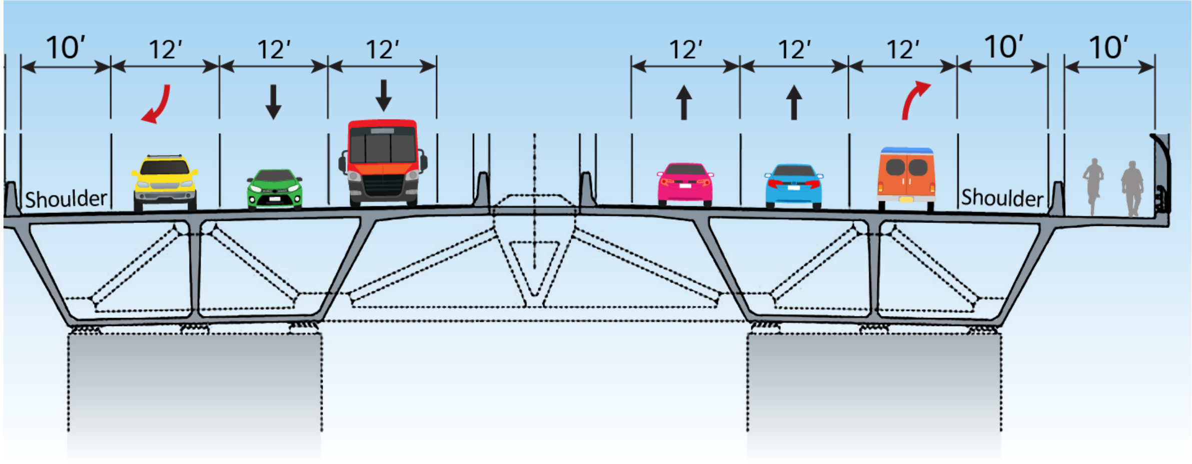
The recommended plan moving into the next phase of design analysis is replacement of each of the two highway bridges crossing the Cape Cod Canal FNP at Bourne and Sagamore. Final design would conform to AASHTO and MassDOT design standards current at that time. Subject to additional analysis during the next phase of the project the new bridges will have two through travel lanes and one acceleration/deceleration lane in each direction. The conceptual design evaluated at this stage of study consists of the following:

1) Construction of two new highway bridges each located parallel to and immediately inshore of the existing Bourne and Sagamore Bridges.
2) Each new bridge would include 4 through travel lanes (2 each direction 12 feet wide).

3) Each new bridge would have two auxiliary lanes for entrance and exit, one in each direction, each 12 feet wide.
4) Each new bridge would have a minimum vertical clearance for navigation of 135 feet above mean high water over the width of the navigation channel, increased 7.8 feet for anticipated sea level change (high rate).
5) Each new bridge would have deck and approach grades of no steeper than 4%.
6) Each new bridge would include one non-vehicular lane for pedestrian and bicycle traffic with separation between the non-vehicular lane and the vehicle traffic lanes.
7) Each new bridge would include a shoulder on the vehicle deck, 10 feet wide, in each direction.
8) Each new bridge would include a median with barriers to separate northbound and southbound vehicular traffic.
9) A conceptual cable-stay design was used for this analysis, but actual bridge type and other design parameters will be developed in the next phase.
10) The existing bridges would remain in service (operated, maintained and repaired as needed) until the new bridges are opened to traffic.
11) The existing bridges would be demolished upon opening of the new bridges. The steel components would be scrapped. The method of demolition and removal would be determined during the next phase.
12) Licenses and easements for placing new electric transmission and telecommunications cables on the new bridges would need to be proposed by the utility owners and negotiated. Placement of new gas lines would not be allowed on the new bridges.
13) Detailed design features such as lighting, fire suppression, suicide prevention barriers, signage and pavement markings, traffic barriers and controls, etc., would be determined during the design phase of the project.

The concept-level cross section used in this analysis is shown in Figure ES-6.

Figure ES-6 – Deck Sections for Conceptual Replacement Bridge Design



The concept for replacement bridges used in this analysis would have two through travel lanes and one auxiliary entrance/exit lane in each direction. Shoulders would also be provided in each direction. A non-vehicle lane for pedestrians and bicycles would be included as would a median to separate directions of traffic.

Recommendation

The USACE has determined that there is sufficient justification for pursuing a program of bridge replacement for both the Bourne and Sagamore highway bridges over the Cape Cod Canal, Massachusetts Federal Navigation Project. An evaluation of costs and benefits indicates that the most cost effective long-term means of providing vehicular crossing of the Canal is replacement of both bridges with new bridges that conform to modern highway design standards. This recommendation considers both safety and reliability of the bridges and the waterway they cross for both surface vehicular and marine transportation. The next phase of the investigation will determine final bridge type and other detailed design parameters, with such further modifications thereto as in the discretion of the Chief of Engineers may be advisable.

The recommendations contained in this report reflect the information available at this time and current USACE Departmental policies governing formulation of individual projects. They do not reflect program and budgeting priorities inherent in the formulation of a national Civil Works construction program nor the perspective of higher review levels within the Executive Branch. Consequently, the recommendations may be modified before they are approved for implementation funding.

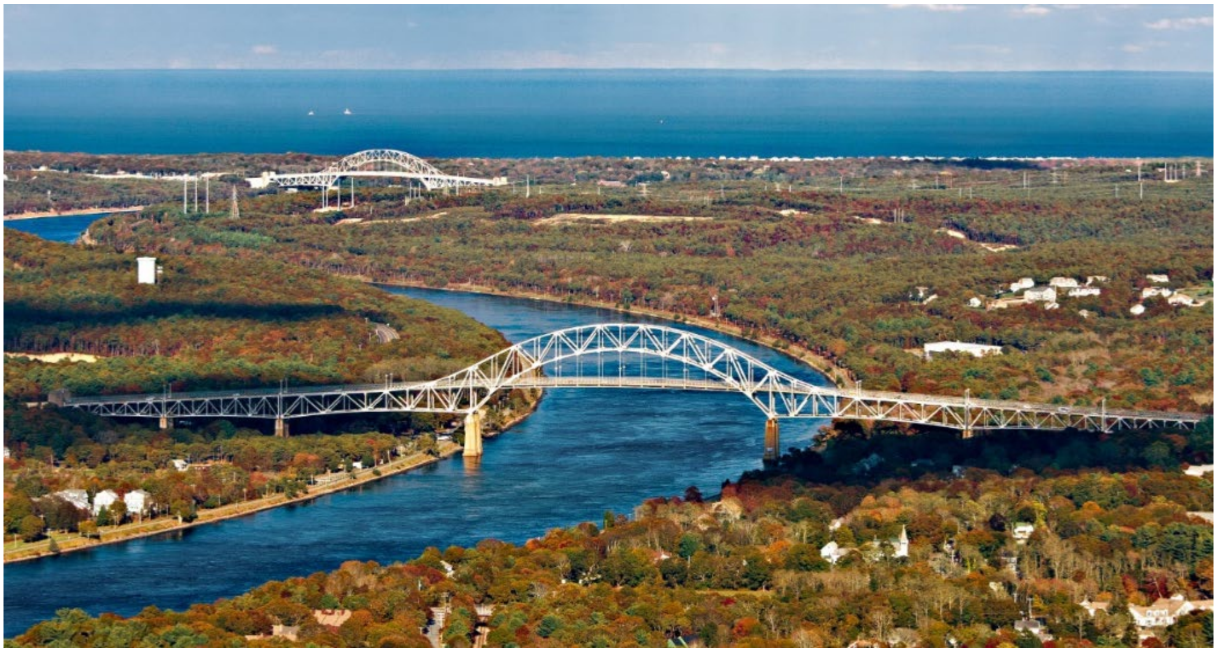


Figure ES-7 – Looking Northeast at the Bourne (foreground) and Sagamore Highway Bridges

This Page Intentionally Left Blank

Major Rehabilitation Evaluation Report
And Environmental Assessment

Cape Cod Canal Highway Bridges Bourne, Massachusetts

US ARMY CORPS
OF ENGINEERS
New England District

March 2020

This Page Intentionally Left Blank

Reverse of Front Cover

Front Cover Photograph: Looking Southwest through the Bourne Bridge to the Railroad Bridge at Buzzards Bay

DEPARTMENT OF THE ARMY
US ARMY CORPS OF ENGINEERS
NEW ENGLAND DISTRICT
696 VIRGINIA ROAD
CONCORD MA 01742-2751

CENAE-PP-C 12 March 2020

MEMORANDUM FOR Commander, U.S. Army Corps of Engineers, HQUSACE (CECW-EC/Dr. Christine Altendorf), 441 G Street NW, Washington DC 20314

SUBJECT: Cape Cod Canal Federal Navigation Project, Bourne, MA, Final Major Rehabilitation Evaluation Report and Final Environmental Assessment for Highway Bridges Replacement

REFERENCE (all enclosed)

a. Policy Guidance Memorandum

b. District Quality Control Certification

c. Agency Technical Review Certification and Report

d. Final Independent External Peer Review (IEPR) Report for Cape Cod Canal Highway Bridges Major Rehabilitation Evaluation Report, Cape Cod Canal Federal Navigation Project, Bourne, Massachusetts

e. Legal Certification of the Cape Cod Canal Highway Bridges Final Environmental Assessment – Phase I

f. USACE Cost Engineering Center of Expertise (CX), Conditional Cost Certification

1. The U.S. Army Corps of Engineers (USACE), New England District, has conducted a multi-year Major Rehabilitation Evaluation Study of the Bourne and Sagamore highway bridges spanning the Cape Cod Canal. The USACE has completed the Final Major Rehabilitation Evaluation Report (MRER) and Environmental Assessment (EA) and is submitting the documents for approval. The MRER provides the basis of decision making for USACE to determine the most cost-effective, safe alternative for critical public transportation access across the Cape Cod Canal. The EA was prepared to analyze the potential environmental effects associated with the project. The report recommends replacement of the two highway bridges as the most long-term economic means of providing vehicular crossings of the waterway.

2. The major rehabilitation study analyzed alternatives to either rehabilitate or replace the existing Bourne and Sagamore highway bridges. This letter notifies you of our completion of the Final MRER and EA, including the incorporation of all District Quality Control (DQC), Agency Technical Review (ATR), and an Independent External Peer Review (IEPR) Type I, Public Review, and Vertical Team Policy & Guidance review comments.

3. The preferred alternative for this project proposes the replacement of both highway bridges with new bridges (consisting of 4 through traffic lanes and 2 auxiliary lanes) to be constructed adjacent to the existing bridges. Design of the new highway bridges will incorporate modern federal highway safety standards such as increased travel lane widths, pedestrian and bicycle lanes with vehicle lanes separation barrier, medians between the two directions of vehicular travel, and shoulders to accommodate vehicle breakdowns, and auxiliary lanes to provide safe vehicle merging for entrance and exit to adjacent interchanges. To minimize impacts to connecting roads, other non-Federal highways, and local roadways, each new bridge would be placed along approximately the same alignment as the existing bridges. The current bridges would remain open and continue to be inspected and maintained in a safe and reliable state while construction of the new bridges is underway. The current bridges would be dismantled and removed once the new bridges have been opened to traffic. The actual type, size, and location of the proposed new bridges, including additional NEPA requirements, the designer of record and agency undertaking the construction, will be determined in the next phase of the Cape Cod Canal Highway Bridges Replacement Project.

4. A copy of the MRER / EA and its appendices is contained on this CD. Please feel free to call me with any questions or comments you may have on this project at 978-318-8220. Additional information can be obtained from the Project Manager, Mr. Craig Martin, at (978) 318-8638 or Craig.A.Martin@usace.army.mil

Enclosures

WILLIAM M. CONDE
COL, EN
Commanding

Copy Furnished:

U.S. Army Corps of Engineers, North Atlantic Division
ATTN: Mr. Joseph Forcina (CENAD-PD-C)
302 General Lee Avenue
Fort Hamilton Military Community
Brooklyn, New York 11252-6700

Cape Cod Canal
Federal Navigation Project
Bourne, Massachusetts

Major Rehabilitation Evaluation Report
Cape Cod Canal Highway Bridges

March 2020

This Page Intentionally Left Blank

Reverse of Front Title Sheet

Cape Cod Canal Highway Bridges
Major Rehabilitation Evaluation Study
Executive Summary

This Major Rehabilitation Evaluation Report (MRER) presents the results of a study examining the relative merits of rehabilitating or replacing the two high-level highway bridges, the Bourne and Sagamore, which cross the Cape Cod Canal, and are part of the Cape Cod Canal Federal Navigation Project (FNP) operated and maintained by the U.S. Army Corps of Engineers (USACE), New England District (NAE). The USACE completes a MRER whenever infrastructure maintenance construction costs are expected to exceed $20 million and take more than two years of construction to complete. The MRER is a four-part evaluation: a structural engineering risk and reliability analysis of the current structures, cost engineering, economic analysis, and environmental evaluation of all feasible alternatives. The MRER is intended only as a means of determining the likely future course of action relative to rehabilitation or replacement. While conceptual plans were developed in order to facilitate the analysis no final determination has been made as to the final location or type of any new Canal crossings. Those would be determined in the next phase of the study and design effort.

Project Purpose and History

The Cape Cod Canal was constructed to provide coastwise shipping traffic with a more direct and safer route from northern New England ports to other areas on the U.S. eastern seaboard. The Canal allows vessels capable of navigating its 32-foot deep channel to avoid the much longer route around Cape Cod, or the even longer route around the islands and Nantucket Shoals. The Canal was originally constructed by the Boston, Cape Cod, and New York Canal Company (Canal Company) under a Charter issued by the Commonwealth of Massachusetts. The Charter required the Canal Company to build and operate two highway bridges and a railroad bridge over the Canal, which were built as low-level draw spans. Construction began in 1909 and the Canal was opened to marine traffic in 1914 and deepened to 25 feet in 1916. The Federal government took control of the Canal during World War I, along with other national transportation infrastructure, and operated the Canal through the 1920s.

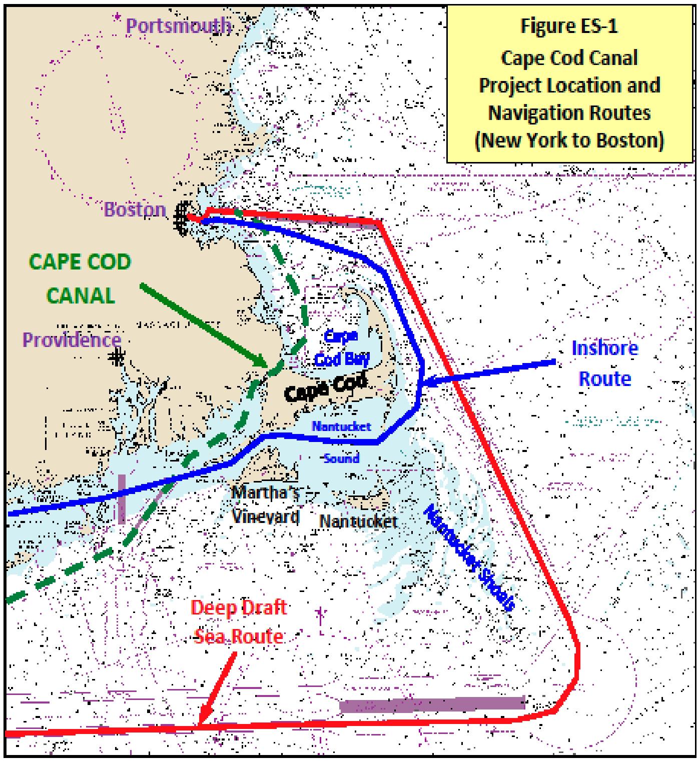


Figure ES-1
Cape Cod Canal
Project Location and
Navigation Routes
(New York to Boston)

The Canal was acquired by the Federal Government in 1928, and the USACE immediately began a program to re-establish the 25-foot channel depth. Under the authority of the National Industrial Recovery Act of June 1933 the Public Works Administration authorized the construction of three bridges over the canal, two highway and one railroad, in keeping with the terms of the original state charter. Work began to widen the channel through the land cut, clearing seaward approaches of obstructions, and provide bank stabilization, lighting and other improvements to navigation. The original plans for Canal deepening called for construction of locks, however this was abandoned in favor of a larger sea level canal after severe icing showed that locks would be impractical.

Work on the two new highway bridges and the railroad bridge began in December 1933, and the two highway bridges were completed in 1935. The Rivers and Harbors Act of August 30, 1935 authorized the USACE to assume maintenance of the three bridges. The 1935 Act also authorized further deepening and widening of the Canal to 32 feet MLW and 17.4 miles long, approach channels in Buzzards Bay 500 to 700 feet wide, with a bottom width of 540 feet in the land cut. That work was completed in 1940. Since that time the USACE has maintained the Canal, its channels, small boat basins, the railroad bridge and the two highway bridges at Federal expense. The bridge locations are shown in Figure ES-2.

The Canal remains an important waterway for coastwise traffic. In 2017 there were more than 21,000 vessel transits of the Canal, of which about 7,500 were ships of more than 65 feet in length. Cargo tonnage for 2016 was about 6.9 million tons. Auto carriers, cruise ships and military vessels are among the largest ships that use the Canal today.

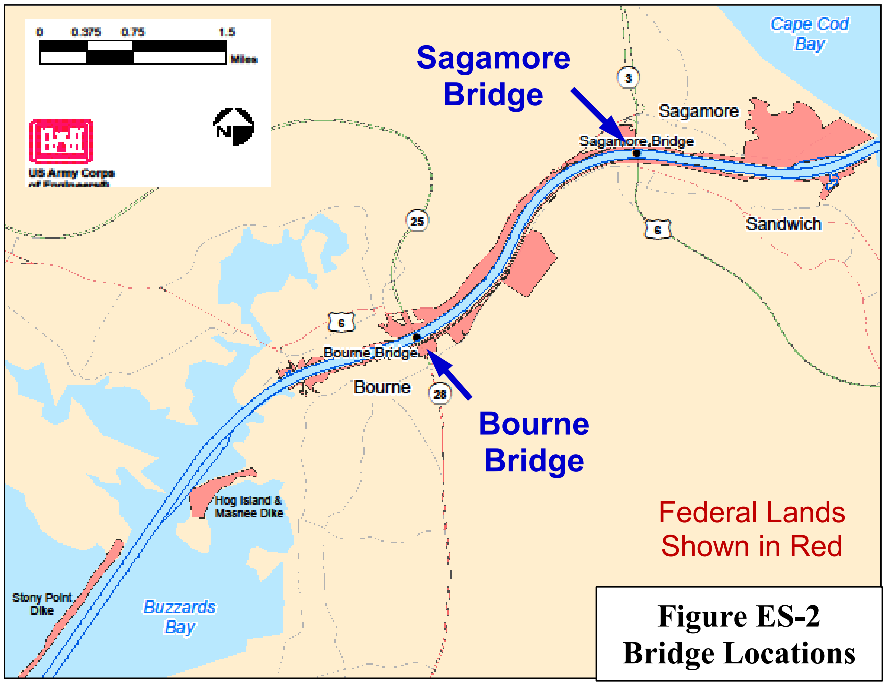


Figure ES-2
Bridge Locations

The two highway bridges are now 85 years old. Both bridges completed their first program of major rehabilitation in the early 1980s. As the bridges and their components continue to age, the cost of operation and maintenance and periodic rehabilitation slowly escalates. Both bridges are now scheduled to undergo their second major rehabilitation in 2025-2027 (Sagamore - $156.3 million) and 2029-2031 (Bourne - $186.2 million). These actions are expected to have impacts on transportation on and off the Cape and the Islands. Most passenger and vehicle traffic to the Islands must cross the Canal bridges to access the ferry terminals on the south shore of the Cape. Lengthy lane closures and full bridge closures would be necessary during the 3 to 7 years of major rehabilitation efforts. Closures of the Canal to marine traffic would also be necessary during some bridge work for the superstructure and deck. These closures would result in costs due to traffic delays, congestion and re-routing, in addition to the costs for bridge rehabilitation itself. Further another major rehabilitation of both bridges would be expected in the 2065-2069 timeframe.

The America's Water Infrastructure Act of 2018, Title I – Water Resources Development, provides additional authority for USACE replacement of the Cape Cod Canal highway bridges. Section 1315 of the act, *Corps of Engineers bridge repair program for New England evacuation routes,* states the following:

> *Subject to the availability of appropriations, the Secretary may repair or replace, as necessary, any bridge owned and operated by the Secretary that is –*
> *(1) located in any of the States of Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, or Vermont; and*
> *(2) necessary for evacuation during an extreme weather event, as determined by the Secretary.*

The Cape Cod Canal highway bridges are the only hurricane evacuation routes off Cape Cod and the Islands. They are the only highway bridges owned and operated by the USACE in New England and so are the only bridges to which this legislative language applies.

Given the high cost of major rehabilitation, the impacts expected to result from such actions, and the fact that major rehabilitation would not address the issues with current and anticipated traffic volumes, modern day highway and bridge design standards, and the escalating costs of normal maintenance and repairs, the USACE is conducting this MRER. The MRER will examine Major Rehabilitation and alternatives for constructing new Canal crossings. Rehabilitation and the alternatives will be measured against a common Base Condition of continued maintenance and repair of the bridges without major rehabilitation to determine the most cost-effective, safe and reliable means of providing vehicular crossing of the Canal. The location of the Canal and its sea routes are shown in Figure ES-1.

The Report

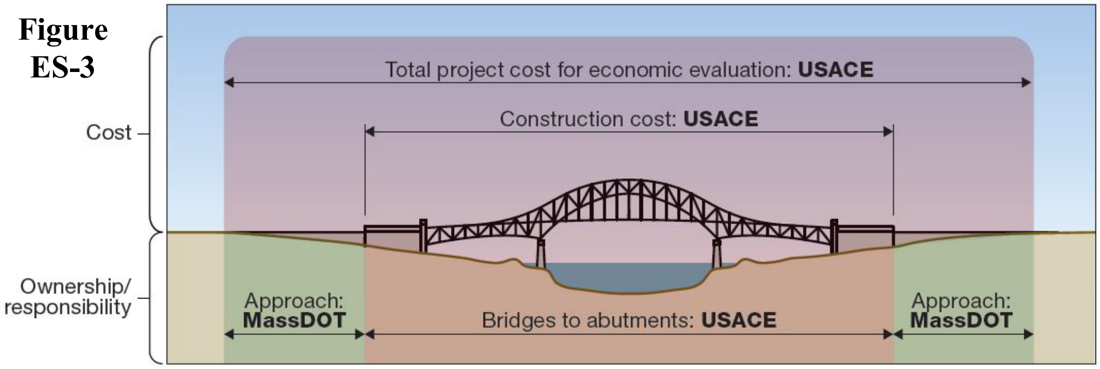
The documents provided include this MRER, and an accompanying Environmental Assessment (EA), necessary to make a risk informed decision, and several appendices providing greater detail on certain topics. A number of additional technical supporting documents (TSD), while not a part of the report, are included in the record as reference material. All studies and reports were prepared to the level of analysis required for identifying and evaluating conceptual alternatives with the goal of determining whether major rehabilitation or bridge replacement would provide the most cost effective, safe, efficient, and reliable means of providing long-term vehicular crossings of the Canal.

Sponsor and Jurisdiction

There is no non-Federal sponsor for the Cape Cod Canal Federal Navigation Project as a whole or for the two highway bridges. The Canal and its appurtenant features were purchased from a private corporation by the Federal government. The modified deep draft portions of the present Canal, the bridges and appurtenant structures were constructed at full

Federal expense without any non-Federal cost-sharing or partnership/cooperation agreements. Federal ownership of the two existing highway bridges covers the area between the shoreward abutments of both bridges as shown in Figure ES-3. Landward of the bridge abutments the Commonwealth (MassDOT) is the land owner and operates and maintains the highway approaches to the bridges.

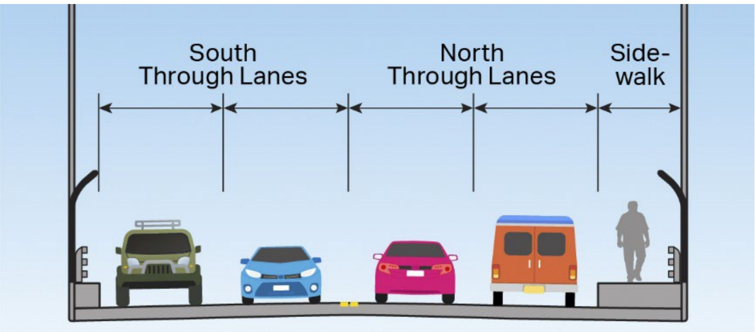
Figure ES-3


Cost
Ownership/ responsibility
Total project cost for economic evaluation: **USACE**
Construction cost: **USACE**
Approach: **MassDOT**
Bridges to abutments: **USACE**
Approach: **MassDOT**

Alternatives

The future of the Canal highway bridges has been the subject of public debate for several decades with a variety of solutions proposed at public meetings and in the press. Beyond the Base Condition limited to continued maintenance and repair of the bridges as needs arise (see Figure ES-4), a number of alternatives were initially examined and screened to yield a final set of plans for detailed analysis. The state and many local stakeholders have sought replacement of the bridges with more modern spans designed in accordance with current highway bridge standards for several decades. With a series of major maintenance and rehabilitation actions projected as necessary in the next ten years to assure safety and performance of the bridges it was decided to examine longer term bridge performance, benefits, costs, and impacts in the context of continued rehabilitation v. replacement. USACE regulation and policy require such projects be evaluated over a 50 year period of analysis.

Figure ES-4 – Deck Section for Existing Bridges



The existing Sagamore and Bourne Bridges have four 10-foot wide vehicle lanes and one combined pedestrian/bicycle lane. There are no shoulders or medians. The left-hand lane in each direction doubles as an auxiliary lanes for entering and exiting traffic.

Major rehabilitation of both bridges followed by additional maintenance, repair, and the next rehabilitation cycle was examined as an alternative. Additionally various methods for new crossings included new bridges, tunnels, causeways, low level v. high level bridges, and closure of the Canal and restoration of the pre-Canal road system. A list of these initial alternatives is provided in Table ES-1.

Table ES-1 – List of Alternatives

	Description	**Special Considerations**
Base A	Continued Maintenance and Repairs (Fix as Fails) of Both Existing Bridges as Needed to Maintain Safety. All alternatives are measured against this plan.	This is the Federal Base Plan – the Without Project Condition
B	A Program of Repairs and Major Rehabilitation for Both Bridges to Maintain Safety and Avoid Future Restrictions on Bridge Weight Postings	Major Rehabilitation of Each Bridge is Required about every 45 Years.
C	Replacement of One or Both Highway Bridges with New Bridges Each Limited to Four Widened Lanes, with Shoulders, Medians, and Sidewalks	Each Old Bridge would Remain in Service until the New Bridge was Completed
D	Replacement of One or Both Highway Bridges with New Bridges as in Plan C, but with Two Auxiliary Lanes Added	Each Old Bridge would Remain in Service until the New Bridge was Completed
E	Replacement of One or Both Highway Bridges with New Bridges with Additional (More than Four) Non-Federally Funded Through Traffic Lanes, plus Two Auxiliary Lanes	Each Old Bridge would Remain in Service until the New Bridge was Completed
F	Replacement of Both Highway Bridges with a Single New Bridge	Both Old Bridges would Remain in Service until the New Bridge was Completed
G	Non-USACE Construction of a New Third Highway Bridge	This would be a State implemented Alternative.
H	Replacement of One or Both Highway Bridges with Tunnels	Each Old Bridge would Remain in Service until the New Tunnel(s) were Completed
I	Replacement of Both Bridges with a Single Tunnel	
J	Replacement of One or Both High Level Bridges with Low Level Draw Spans	Each Old Bridge would Remain in Service until the New Bridge was Completed
K	Replacement of Both Bridges with Low Level Crossings on Causeways with Draw Spans for Shallow Draft Navigation	Both Old Bridges would Remain in Service until the New Causeway was Completed
L	Deauthorization and Closure of the Cape Cod Canal, Filling the Land Cut, and Restoration of Surface Highways, Drainage and Estuarine Ecosystems	Includes Retention of the Shallow Draft Harbors at Each End of the Canal (East Boat Basin, Buttermilk Bay and Onset Bay Projects

These initial alternatives were then evaluated and screened to reduce the list to only those plans which in terms of likely cost, impacts on the marine and land transportation systems, traffic and environmental impacts, and overall practicability would be implementable.

Alternative A, the Base Condition for continued maintenance and repair, was carried forward so as to provide a baseline against which the other alternatives could be measured. Alternative B, major rehabilitation of each bridge was also carried forward so that the ability to avoid the cost of replacement by extending the life of the bridges could be examined.

Alternatives (J, K and L) which involved closure of the Canal by filling, or construction of causeways or low-level fixed bridges or draw spans were eliminated from further consideration. Some of these plans would also constrain navigability or eliminate the Canal as a shallow draft waterway. These alternatives would degrade the efficiency and safety of coastwise navigation as some or all of the Canal's marine traffic would be diverted to the Atlantic shipping routes to the south and east of the Cape, Islands, and Nantucket Shoals. Increased risk and cost to shipper, fishermen and boaters would all result from any of these three plans. Restricting or closing the Canal to navigation would be inconsistent with the Congressional authorization for the Canal as a deep-draft waterway and would require legislation to implement.

Plans involving tunnels (Alternatives H and I) were eliminated from detailed analysis based on high costs and extensive impacts on the environment and land uses. An examination of recent tunnel projects elsewhere on the east coast indicated that tunnels as new Canal crossings, whether trenching for immersed tubes or much longer and deeper bored tubes, would carry at least twice the cost of new bridges.

Construction of a new single bridge (Alternative F) or additional "third" bridge (Alternative G) were also eliminated based on cost and impact. A single bridge as replacement of the two existing bridges would require extensive relocation and realignment of the state and local road systems to change the approaches on both sides of the Canal to align with the new crossings. Extensive and costly real estate takings would be required. Impacts to natural resources including wetlands, agricultural lands, homes and businesses would occur. Overall a third or single bridge was not considered practicable.

Provision of two new bridges to replace the existing bridges, but with the deck of each bridge limited to carrying two lanes in each direction (Alternative C - in other words without auxiliary lanes) was also eliminated from detailed consideration based on comments received during review of the draft report. While such a design is within the Corps existing authority to provide vehicular crossings over the Cape Cod Canal, a design that eliminates auxiliary lanes in this situation would not be consistent with modern highway design under FHWA design standards and MA DOT guidelines. Carrying this alternative forward for detailed consideration would therefore be contrary to best engineering practices. This alternative was therefore not carried forward for detailed study in the final report.

Replacement of the two bridges with new bridges carrying additional through-traffic lanes (Alternative E) was also eliminated. While auxiliary lanes for acceleration/deceleration to improve safety and efficiency of entrance and access to the bridges from the local area could be included, additional through-traffic lanes would not be in accordance with the existing authority of the Federal government for the Cape Cod Canal navigation project. New Federal legislation would be required for any expansion of capacity to be implemented. Additional through traffic lanes would not generate appreciable benefits to traffic without extensive state improvements to region's highway capacity on both side of the Canal, which would carry high costs and greater impact to the environment and the communities. Further the state has indicated it would not support state-funded additional through traffic lanes for the bridges as this would also require more extensive improvements, including adding lanes, to the regional highway network to yield any benefit. This plan was therefore eliminated from further consideration.

Provision of two new bridges to replace the existing bridges with auxiliary lanes included on the bridge decks was carried forward for detailed analysis (Alternative D). Provision of two replacement bridges at Bourne and Sagamore, each with two through travel lanes and one auxiliary lane in each direction, is within the Corps existing authority to provide vehicular crossings over the Cape Cod Canal, and no additional authorizing legislation would be required. Provision of auxiliary lanes in addition to two through traffic lanes conforms to FHWA and MA DOT design guidelines and would address issues with traffic safety. Other than modifications and realignment of approach roads no more extensive state improvements to the regional highway system would be required. MassDOT's plans for eliminating bottlenecks in the vicinity of the bridges with improvements to adjacent supporting state highway infrastructure are discussed in their 2019 Cape Cod Regional Transportation Study. Impacts from bridge and supporting state highway construction would be minimized by locating new bridges in close proximity to the existing bridges. This alternative was therefore carried forward for detailed analysis.

Detailed Plans

Three alternatives were carried forward for development and evaluation of detailed plans. These included Plan A – the Base Condition for continued maintenance and repair as needed; Plan B – major rehabilitation of both existing bridges followed by regular maintenance, repair and eventually another rehabilitation action with the 50-year period of analysis; and Plan D – Bridge Replacement for both bridges with 6 vehicle lanes.

Table ES-2 – List of Alternative Plans Carried Forward for Detailed Analysis

Plan	Description	Special Considerations
Base A	Continued Maintenance and Repairs to Both Existing Bridges as Needed to Maintain Safety (Fix as Fails)	This is the Federal Base Plan – the Without-Project Condition or the No Action Plan
B	A Program of Repairs and Major Rehabilitation for Both Bridges to Maintain Safety and Avoid Future Restrictions on Bridge Weight Postings	Major Rehabilitation of Each Bridge is Required about every 45 Years.
D	Replacement of One or Both Highway Bridges with New Bridges having Four Through-Traffic Lanes and Two Acceleration/Deceleration Lanes	Each Old Bridge would Remain in Service until the New Bridge was Completed

Engineering Reliability

An engineering analysis was performed to demonstrate the reliability of major components of the Bourne and Sagamore bridges. The major components of the bridges are the substructure (piers and abutments), the superstructure (largely the steel trusses supporting the deck and attaching to the substructure), and the deck itself. The results of this analysis forms the basis for the economic evaluation of the base condition versus plans for repair or replacement.

A timeline of anticipated component failures was developed along with a schedule of likely repairs and costs. The history of bridge repairs and rehabilitation, condition ratings, performance/deterioration models, and fatigue and corrosion analyses are all used to establish projected reliability of the components. Reliability is defined as the probability that unsatisfactory performance will not occur. Reliability calculations were prepared for each component for each year of the 50-year analysis period. For this study, the limit state for unsatisfactory performance is defined by the physical condition of the bridge's major components. This "limit state" is the point at which either unsatisfactory performance will occur or the engineering consequences will have some adverse economic impact.

Unsatisfactory performance of one or more of these critical elements would lead to unsatisfactory performance of the entire bridge. In order to assess the engineering reliability of the bridges, a probabilistic hazard function was developed for each of the three critical elements. For each major component, a probability distribution was developed to predict deteriorating bridge element performance over a fifty-year service life. The consequences of unsatisfactory performance are presented on an event tree for each critical element under each economic alternative.

Potential repair actions that would likely be necessary over the 50-year period of analysis are added to event trees, costs for each action are estimated, and statistical analysis is employed to weight those costs in terms of the likelihood of required actions to maintain bridge performance. Component failures and repair actions to address them will also have impacts on vehicular and marine traffic in terms of transportation delays. Lane and bridge closure results in transportation cost increases from delays and diversion of traffic. Total cost is the adjusted construction cost for repairs plus the transportation delay costs incurred by users of the bridges, all resulting from the reliability analysis.

Analysis of Detailed Plans

The Base Condition (Plan A) and the two plans carried forward for detailed analysis (Plan B – Major Rehabilitation and Plan D – Bridge Replacement) are discussed below. All costs and benefits are provided in FY20 price levels. Cost estimates prepared at this phase were developed at a conceptual level to compare rehabilitation vs. replacement and are not intended for budgeting purposes.

Plan A – the Base Condition was developed using the engineering reliability analysis as described above. Regular maintenance would continue and repairs to bridge components would be made as needed. Possible repairs cover a wide range of possibilities from deck resurfacing to emergency bridge replacement due to failure of critical components. Increased transportation costs include the potential for future posting of weight restrictions on the bridges. The cost of making repairs on an as needed or emergency basis and the cost of transportation delays (traffic and marine) are summed to arrive at total costs for this plan. These costs are then evaluated using probabilistic simulations that are described below in the economic analysis. The results serve as the baseline for measuring the costs and benefits of the other detailed plans.

Plan B – Major Rehabilitation of the existing bridges required a similar analysis of anticipated reliability and performance over time. Costs and schedules for the rehabilitation actions were identified along with those for post rehabilitation repairs and the next cycle of rehabilitation which would occur before the end of the 50-year period of analysis. The future costs were then reduced to their present worth. Major rehabilitation would also have impacts on transportation delays and costs. The construction cost for major rehabilitation and major repairs over the 50-year period of analysis is shown in Table ES-3. Bridge and lane closure days for the initial major rehabilitation action are shown in Table ES-4.

Table ES-3
Major Rehabilitation Costs – Bourne and Sagamore Bridges

Item/Component and FY 2020 Costs (October 2019 Price Levels)	Bourne Bridge 2029-2031	Sagamore Bridge 2025-2027
Total Major Rehabilitation Cost	$186,171,000	$156,301,000
Maintenance – Complete Painting (2049/45)	$26,827,000	$33,425,000
Third Major Rehabilitation Bourne 2069 – Sagamore 2065	$132,120,000	$110,940,000
Total Rehabilitation and Major Repairs	$345,118,000	$300,666,000
Note: Updated March 2020 - Does not include annual maintenance and minor repairs		

TABLE ES-4
Anticipated Traffic Management for Lane and Bridge Closures
With Major Rehabilitation 2025-2031

Major Rehabilitation Activity	Bourne Bridge	Sagamore Bridge
Total Days of Lane Closures	480	380
Total Days of Full Bridge Closures	180	130

Plan D - Bridge Replacement includes higher up-front costs for construction, but has far lower costs for maintenance and repair over the 50-year period of analysis. The bridge replacements also would have far fewer impacts on transportation costs as maintenance, repair and future rehabilitation would be limited. The existing bridges would remain in service while the new bridges were built and the new bridge construction would have minimal impacts on adjacent roads. There would be some temporary impacts to marine transportation through the Canal during new bridge construction, but less impacts over time. State construction of realigned approach roads would have an impact on land transportation costs.

The conceptual design chosen for evaluation of new bridges at this phase of the analysis used a cable-stay design for both replacement bridges. This conceptual design included consideration of sea level change, reduced deck grades, wider traffic lanes, shoulders, medians, and bicycle/pedestrian walkways. The location and alignment of any new bridges would be determined during the next phase of investigation and design. For this level of analysis it was assumed that the new bridges would be built adjacent to the existing bridges. The area for potential siting for the replacement bridges is shown in Figure ES-5.

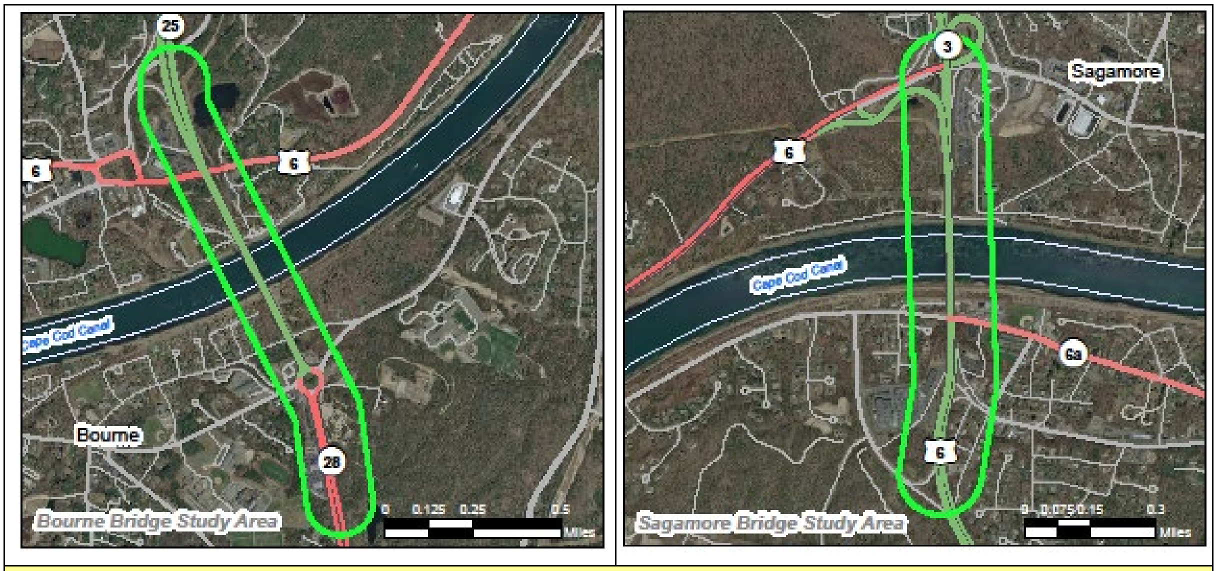


Figure ES-5 – Concept Level Siting Areas for Replacement Bridges

Plan D also consists of replacement of the two highway bridges each with six lanes (two through travel lanes plus one auxiliary lane in each direction). The additional auxiliary lanes for exit and entrance would address traffic safety concerns by allowing for two unobstructed through travel lanes each way. Vehicles in the right-hand travel lane in each direction would not be slowed by merging and decelerating traffic on the bridges. This plan also considered sea level rise, reduced bridge deck grades, and other improved design elements including shoulders, medians, and pedestrian/bicycle lanes separated from the vehicle lanes. The estimated cost for each bridge under Plan D is shown below in Table ES-5.

Table ES-5
Project Costs – Bridge Replacement Alternatives – Plan D

Cost Category ($000s) FY 2020 Price Levels	Bourne Bridge	Sagamore Bridge
Construction Cost	$355,478	$232,630
Contingency Cost (44%)	$156,410	$102,357
Planning, Engineering & Design	$40,951	$27,321
Construction Management	$14,199	$9,594
Total Construction	$567,038	$371,902
Cultural Resource Preservation	$29,450	$19,241
Lands, Easements, ROW	$7,645	$7,618
Utility Relocations	$26,640	$29,520
Total Federal Project Cost	$630,773	$428,281

Table ES-5 (Continued) – Costs	Bourne Bridge	Sagamore Bridge
Associated Non-Federal Highway/Roadway Modifications		
State-Funded Bridge Approaches	$90,991	$57,802
Anticipated Future Major Repair Actions for New Bridges (Bourne/Sagamore)		
Major Repairs #1 (2054/2049)	$7,911	$7,906
Major Repairs #2 (None/2069)	- - -	$7,906
Total Project Cost (50 Years)	$729,675	$501,895
Note: Estimate Revised March 2020		

Economic Analysis

As part of this MRER, an economic evaluation was performed to analyze the costs and benefits of the Base Condition and compare it to alternatives, including major rehabilitation and bridge replacement. Costs and benefits are in FY20 price levels. The Base Condition refers to a baseline of continued regular inspections and standard maintenance construction on the bridges. The economic analysis is extended over a 50-year period using 2020 as the base year and the Federal Discount Rate currently set at 2.75 percent for Federal Fiscal Year 2020. Below is a brief summary of the findings of the economic analysis.

The economic analysis focused on the base plan and the two detailed plans described above:

1. Alternative A: Base Condition (Without-Project)
2. Alternative B: Major Rehabilitation of both Existing Bridges
3. Alternative D: Replacement with Two 4-Lane Bridges with Auxiliary on/off Lanes

Annual benefits considered for each alternative include the reduction in emergency repair spending, the decrease in traffic delays, and changes in cost to waterway navigation. The annual benefit of each alternative is then compared to its respective cost. An alternative is considered economically justified if it maximizes net annual benefits and its benefit cost ratio (annual benefit divided by annual cost) is greater than one.

The analysis is performed using a risk based approach to compare costs and benefits of each alternative to the Base Condition. Reliability functions from the engineering event trees are utilized to simulate possible component failures and associated repair costs. The three engineering components that could experience failure are the *bridge deck, substructure,* and *superstructure*. This analysis is evaluated over a 50-year period using Monte Carlo Simulation to determine the likely long-term costs of the future Base Condition without the project and the future condition with each alternative. The model was approved for single-use by the USACE Planning Center of Expertise for Inland Navigation and Risk Informed Economics Division in July 2018. The memo documenting this approval pursuant to EC 1105-2-412 is attached as an addendum to Appendix D - Economics.

The overall cost of each alternative includes several elements; the cost of the repair itself, the economic cost to vessels that cannot use the canal (navigation costs), operation & maintenance costs, and the change in value of time incurred by drivers in traffic delays (travel costs) during lane and bridge closures for repairs or construction phases.

The value of time is determined using USACE regulation (ER 1105-2-100). Traffic data was modeled by TrafInfo; a transportation consulting company familiar with the Massachusetts Department of Transportation (MassDOT) data. TrafInfo provided Cape Cod traffic study data and forecasts. This traffic data was used to determine the total hours of traffic delay incurred during construction for all travelers crossing the bridges. A monetary value was attributed to these lost productive hours using the average hourly household median income of the surrounding towns as sourced from the US Census Bureau.

A comparison of mean annual costs for the base condition and two detailed plans is provided in Table ES-6 below. These costs represent the economic impacts of unscheduled component failures and unscheduled maintenance events that will occur over the 50 year period of analysis. Maintaining the bridges in the current, base condition would result in annual repair and transportation costs of $123.9 million and $65.2 million for the Sagamore and Bourne Bridges respectively. Under the Major Rehabilitation scenario, those expenses would decrease to $8.8 million for the Sagamore Bridge and $6.1 million for the Bourne Bridge. Replacing the bridges reduces the annual costs for the Sagamore Bridge even further to approximately $4.5 million. Costs for the Bourne Bridge increase slightly to $7 million.

Table ES-6
Mean Annual Costs for All Plans
Results from Monte Carlo Simulations ($000)

FY2020 Price Levels	Repair Cost	Travel Cost	Navigation Cost	O&M Cost	Total
Plan A – Base Condition					
Sagamore	2,800	120,700	1	400	123,900
Bourne	3,200	61,700	1	300	65,200
Plan B – Major Rehabilitation					
Sagamore	300	0.6	8,000	400	8,800
Bourne	400	0.6	5,400	300	6,100
Plan D – Bridge Replacement – 4 Lanes plus Auxiliary Lanes					
Sagamore	300	0.1	4,000	200	4,500
Bourne	500	0.2	6,300	200	7,000

Tables ES-7 provides summary detail of all annual costs, benefits, and benefit to cost ratios (BCRs) for the major rehabilitation and bridge replacement plans.

Table ES-7 – Comparison of Rehabilitation and Replacement Plans		
FY 2020 Price Levels ($000s) Revised February 2020	**Plan B - Major Rehabilitation**	**Plan D – Bridge Replacement**
Sagamore Bridge		
Total Federal First Cost	$156,300	$428,300
Future Federal OMR&R	$144,400	$15,800
State-Funded Approaches	- - -	$57,800
Travel Delay Costs	$1,281,000	$92,800
Total – Sagamore	$1,581,700	$594,700
Total Cost Discounted + IDC	$969,500	$469,000
Total Annual Cost – 2-3/4%	$35,600	$17,400
Discounted Cost – Base Plan	$123,900	$123,900
Discounted Cost – Plan B & D	$8,800	$4,400
Total Annual Benefits	$115,100	$119,500
Annual Net Benefits	$79,200	$102,100
Benefit-Cost Ratio	3.2	6.9
Bourne Bridge		
Total Federal First Cost	$186,200	$630,800
Future Federal OMR&R	$158,900	$7,900
State-Funded Approaches	- - -	$91,000
Travel Delay Costs	$948,300	$22,400
Total – Bourne	$1,293,500	$752,100
Total Cost Discounted + IDC	$731,100	$574,400
Total Annual Cost – 2-3/4%	$27,100	$21,300
Discounted Cost – Base Plan	$65,200	$65,200
Discounted Cost – Plan B & D	$6,100	$7,000
Total Annual Benefits	$59,100	$58,300
Annual Net Benefits	$32,000	$37,000
Benefit-Cost Ratio	2.2	2.7

Based on Net Benefits, the rank of alternatives (with 1 being the most desirable) is:

1. Alternative D: Replacement with two 4-lane bridges with auxiliary on/off lanes
2. Alternative B: Major rehabilitation of existing bridges
3. Alternative A: Base Condition - continue to maintain the bridges with regularly scheduled maintenance and make emergency funding available when there is a component failure to repair the failure.

The economic analysis suggests that fixing the current bridges as components deteriorate will lead to greatly increased costs, particularly costs for travelers delayed in traffic.

Major rehabilitation of the existing bridges demonstrated positive net benefits and a benefit-cost-ratio (BCR) of 3.2 for the Sagamore Bridge and 2.2 for the Bourne Bridge. One advantage of the rehabilitation is a lower initial construction cost for the project when compared to replacing the bridges. The disadvantages are the impact it will have on traffic patterns during the time of construction due to lane and full bridge closures as well as the bridges not being brought up to current engineering standards and regulations.

The alternative for replacement bridges (two 4-lane bridges with auxiliary lanes) had higher net benefits and BCRs than the rehabilitation scenario. One disadvantage of the new bridges is the high initial cost of construction. On the other hand, advantages of the replacement bridges are minimal disturbances to traffic during construction and replacing the aging infrastructure with bridges at current engineering standards and regulations. Bridges with auxiliary lanes would also result in less traffic delays during minor repairs and inspections as two lanes in each direction could remain open in many circumstances.

The analysis suggests that the two replacement bridges are more economically justifiable given the lower costs. However, it is important to note that this analysis was performed under the assumption that the infrastructure and surrounding roadways to the bridges remain in their current conditions and are not upgraded by the Commonwealth of Massachusetts. If the state choses to improve the road network surrounding the bridges, particularly near the Bourne Rotary, then bridge replacement will provide additional benefits to improved travel time that could increase the net benefits and BCRs. The bridges with four through traffic lanes and two auxiliary lanes can also reduce the impact to the traveling public when performing future maintenance on the bridges.

Environmental Impact Analysis

Environmental conditions and impacts have been evaluated in the Environmental Assessment based on a conceptual bridge design. Resources and potential impacts will be more fully defined and analyzed when the project moves to the design phase. Considerations examined included land uses, geography and geology, climate, air quality, contaminants wetlands, water resources, water quality, terrestrial and marine wildlife, fisheries, threatened and endangered species, environmental justice, and other areas of concern. Removal of the existing bridge once any new bridges are placed in service was also considered with respect to impacts from demolition. Indirect impacts such as local traffic conditions, induced development potential, and population changes were considered. Cumulative impacts from state highway improvement and other proposed development projects were also considered.

This study and preparation of the documents has followed USACE regulations and policy for MRERs and the NEPA process. Five agencies were invited to participate as cooperating agencies for the MRER: MassDOT, Federal Highway Administration (FHWA), U.S. Coast Guard, Environmental Protection Agency (EPA), and National Marine Fisheries Service (NMFS), and all agencies accepted. Representatives from Federal, state, and local agencies, and federally-recognized Tribes with interest or jurisdiction in the proposed project were invited to a scoping meeting and coordinated site visit on March 19, 2019.

Early coordination was also conducted with several resource agencies including: U.S. Fish and Wildlife Service, National Marine Fisheries Services, MA Office of Coastal Zone Management, and MA Historic Preservation Office to discuss project plan formulation and consider potential impacts to specific resources and agency comments and concerns. Further consultations will continue during Phase II of the project with these and additional agencies and interests.

Public involvement at this stage consists of public meetings held at the beginning and end of the study process, receipt and consideration of public input throughout the process, and public review and comment on the draft MRER and EA before reports are finalized and any decisions are made.

During the next phase of investigations additional studies will be performed in a more focused effort as plans for bridge location and alignment, and associated state sponsored improvements are more fully designed and considered.

Cultural Resource Concerns

Section 106 of the National Historic Preservation Act (NHPA) requires that a federal agency take into account the effects of an undertaking on historic properties. In the study area, there are three historic period resources, the Bourne and Sagamore bridges, and the canal. There are no identified archaeological resources in the vicinity of the Sagamore Bridge study area. There are two archaeological sites within the vicinity of the Bourne Bridge. The Base Condition and Major Rehabilitation would have little to no impact on cultural resources. Impacts from construction of replacement bridges will depend on final locations and their proximity to any known resources or resources identified during the next phase of the project. Additional cultural resource survey will be required to determine the extent and nature of any impacts and the appropriate response. Construction of new bridges will include demolition and removal of the existing bridges. Compliance with the NHPA will require preparation and execution of a Memorandum of Agreement to avoid, minimize, or mitigate effects to historic properties.

Cultural resources coordination was initiated with the State Historic Preservation Officer (SHPO), Tribal Historic Preservation Officers (THPOs) of the Mashpee Wampanoag and the Wampanoag Tribe of Gay Head (Aquinnah), and the Historic Commissions of the Towns of Bourne and Sandwich. Additional consultation with these agencies on the location of the bridges and the bridge design would be required during the next phase of the project.

Real Estate Considerations

Neither the Base Condition nor Major Rehabilitation would require additional lands, easements or rights of way. Bridge Replacement would require acquisition of new lands by the Federal government for the new bridge footprints. The state may also need to acquire new lands for modified approach and connecting roads. While final location and alignment of the two new bridges would be determined during the next phase of investigation and design, for the purposes of this analysis it was assumed that the new bridges would each be located next to and inland of the existing bridges. This location would minimize land takings as existing

Federal and state properties would be used for much of the footprints and local connecting and state approach roads would require minimal realignment.

At this level of analysis it was estimated that replacement of the Bourne Bridge would require acquisition of about 11 acres of land and their improvements and relocation of businesses, all totaling about $7.6 million. A new Sagamore Bridge would require about 4.5 acres of new land plus improvements and relocations also totaling about $7.6 million.

Major Rehabilitation and Bridge Replacement would require utility relocations including electrical power and telecommunications cables and several natural gas transmission lines, all of which are beneath the current bridge decks. Full deck replacement and some major steel repairs would require removal of these utilities. Utility cables could be moved to the new bridges once they were completed. Gas lines crossing the bridges would need to be relocated. Utility relocation costs are estimated to vary from $56.9 million for replacement to $25.5 million for rehabilitation. These utility costs were based on the number of crossings and similar replacement costs on recent projects in the region. Discussions with utility owners and operators have begun and will continue into and throughout the design phase of the project. As final bridge location, alignment, type, and need for state connecting road improvements become better defined utility needs will also refined. Specific utility costs, and the allocation of those costs between the utility owners and the Government, will be developed during the design phase in consultation with the utility owners and the state.

Other Social Effects

The Bourne and Sagamore bridges provide the only vehicular access to the 15 towns of Cape Cod with nearly 215,000 year-round residents and a population increase of up to 300 percent during the height of the summer tourist season between Memorial Day and Labor Day. The bridges also provide access to the eight offshore island municipalities through the ferry terminals located on the south shore of Cape Cod. Traffic volumes have increased exponentially since the 1930’s leading to significantly increased loading on the bridges with the result of increasingly frequent maintenance and repair events.

Frequent lane closures, coupled with the lack of auxiliary lanes, mean that for much of the time there is only one through traffic lane in each direction on both bridges. Backups for travelers waiting to cross the bridges commonly stretch for several miles, particularly on late spring through early fall weekends when vacationers crowd the Cape and Islands. The extent of traffic delays is a source of frustration for many residents and visitors, especially as summer tourism brings significant income to area residents and businesses.

Conclusions

The objective of the MRER is to identify the plans that most efficiently and effectively meets the long-term requirement for the Federal Government to provide, operate, maintain, repair, rehabilitate, and replace (OMRR&R) crossings of the Cape Cod Canal for vehicles, pedestrians and other surface traffic. Engineering reliability of the structures, when analyzed together with cost and economic benefits form the basis of the analysis and determine the recommended plan.

In conducting this study the following tasks were performed: (i) the deficiencies of the components of the two existing highway bridges (Sagamore and Bourne Bridges) were identified, (ii) their reliability indices were estimated, (iii) impacts to road traffic and marine traffic from component failure were estimated, (iv) the increases in reliability based on each improvement alternative were estimated, (v) economic benefits were estimated, and (vi) costs to repair deficient components or replace the bridges were estimated. All of these tasks provided inputs to the economic evaluation of alternatives. Increases in reliability, with respect to the costs to attain them, in order to continue safe and reliable navigation and highway access, was the ultimate objective of this evaluation.

The cost estimates presented in this report were developed based on concept level plans and are not adequate for use in budgeting for implementation. Cost certification at this phase is conditional due to the limited scope of the analysis. The next phase of the project will include more detailed investigations, final bridge locations and designs, and more detailed and refined cost estimates.

The cost of repairs or rehabilitation are only part of the analysis. The total economic impact to travelers from lane, bridge and waterway closures during the major rehabilitation of the Sagamore Bridge is estimated to be $782.6 million and $536.7 million (discounted delay cost) for the Bourne Bridge Rehabilitation project. Total transportation delay costs over the 50-year period with the major rehabilitation plan (B) would be $1,281.3 million for the Sagamore and $948.4 million for the Bourne. In contrast the 50-year costs for construction for the rehabilitation plan are $300.7 million for the Sagamore and $501.9 million for the Bourne. The bulk of the cost impact for the rehabilitation plan will fall on the travelling public, about 83% of the cost for the Sagamore and 78% of the cost for the Bourne.

The bridge replacement alternative (Plan D) had higher net benefits and a higher BCR than the major rehabilitation plan. The disadvantage of the replacement bridges is the high initial cost of construction. The advantages of the replacement bridges are minimal disturbances to traffic during construction and replacing the aging infrastructure with bridges that meet modern engineering standards and regulations. The new bridges would not require the level of frequent, costly, and escalating maintenance and repairs, or entail the high level of disruption to traffic and the economy of the region.

It is important to note that this analysis was performed under the assumption that the road infrastructure surrounding the bridges are in their current conditions and are not upgraded by the Commonwealth of Massachusetts. If the state choses to improve the road network surrounding the bridges as suggested in the draft Cape Cod Transportation Study, particularly near the Bourne Rotary and the improvements to Route 6, then the replacement bridges will provide additional efficiency benefits of improved travel time by allowing the left-hand travel lanes to be fully used by through traffic, since exiting and entering traffic would use the auxiliary lanes. Shifting the exiting and entering traffic out of the right-hand through traffic lanes will also have benefits to traffic safety as conflicts between fast-moving and slow moving vehicles will be minimized.

New replacement bridges would have significantly higher reliability and lower probability of failure than the existing bridges would have moving forward with the rehabilitation plan. The distribution of costs for the replacement is nearly the reverse of that for the rehabilitation plans. Transportation delay costs to the public and users of the Canal with bridge replacement account for only about 16% of total costs for the Sagamore and 3% of total costs for the Bourne. This compares to 81% and 73%, respectively for each bridge under the rehabilitation plan. Moving from rehabilitation to replacement shifts the cost burden from the public (delay costs), to the Government (construction and repair costs). The calculations for cost distribution are provided in Table ES-8.

Table ES-8 – Cost Distribution Comparison
Plan B Bridge Rehabilitation v. Plan D Bridge Replacement

FY20 Price Levels Revised Feb 2020	**Rehabilitation**	**Replacement**
Sagamore Bridge		
Repair/Replace Costs	$300,700	$501,900
Delay Costs	$1,281,300	$92,800
Total Costs	$1,582,000	$594,700
Repair as %	19.0%	84.4%
Delay as %	81.0%	15.6%
Bourne Bridge		
Repair/Replace Costs	$345,100	$729,700
Delay Costs	$948,400	$22,400
Total Costs	$1,293,500	$752,100
Repair as %	26.7%	97.0%
Delay as %	73.3%	3.0%

The two existing bridges are now coming up on their second major rehabilitation. The rehabilitation of the Sagamore Bridge would be scheduled for 2025-2027 and cost about $156.3 million (FY20), or $188.8 fully funded (through the midpoint of construction). The rehabilitation work on the Bourne Bridge would be carried out in 2029-2031 at a cost of about $186.2 million (FY20), or a fully-funded cost of about $252.1 million. During these periods the work would require a total of about 760 days (or more than 2 years) of lane closures and 310 days (or more than 10 months) of full bridge closures, with consequences to traffic and the local economy.

A program of critical repairs may be able to delay the full rehabilitation starts by a several years, but if bridge replacement is approved any delay in implementing that work would require rehabilitation to proceed. In other words, any appreciable delay in decision-making or funding could force the Government to pursue major rehabilitation instead of bridge replacement in order to maintain reliability and safety of vehicular traffic over the Canal in the near term.

The Commonwealth of Massachusetts would be a necessary partner in any rehabilitation or replacement project. However the State's principal role would involve redesign and relocation of connecting highways and roadways if bridge replacement is pursued. The State has made a capital investment of $10 million dollars to begin environmental coordination and early design work for adjacent infrastructure and new bridge approaches in 2020. In addition, the Commonwealth has proposed more than $350 million in future infrastructure funds in their 2019 Transportation Bond Bill for work in the coming years. The work needed includes study, design and construction of transportation infrastructure associated with the approaches to the Bourne and Sagamore Bridge as a part of the Cape Cod Bridges Improvement Program within the *Act Authorizing and Accelerating Transportation Investment*, Section 2A, 6121-2147. Any delays in Federal funding could put that commitment and associated work in question.

There is a level of urgency in Federal and State decision making concerning the recommendation and funding to implement the design and construction of new bridges. Approval of this report and its recommendation for two replacement bridges to include auxiliary lanes (Plan D) would allow the USACE to proceed with the next phase of the process – the identification of the final replacement bridge location, alignment, size and type, complete Federal, State and local regulatory coordination, including conclusion of the NEPA process, and initiate final design.

The Recommended Plan

This study has determined that providing two new highway bridges would be the most cost effective means of providing safe and reliable crossings. The existing bridges are 85 years old and both are functionally obsolete. The Bourne Bridge is also classified as structurally deficient under current Federal Highway Administration guidance.

Conceptual designs for two replacement bridges have been developed to facilitate this analysis and recommendation. Specific design features would be developed in the following phase of implementing this project. For purposes of this level of analysis it was assumed that a new high level fixed span bridge would be constructed immediately adjacent to each of the two existing highway bridges so as to minimize the modifications needed to the connecting roadways on both the mainland and the Cape. The new highway bridges would be designed to include access for both pedestrians and other non-vehicular traffic such as bicycles. To improve traffic safety and through traffic reliability each bridge would include one acceleration/deceleration lane and two through traffic lanes in each direction, for a total of six vehicular lanes on each bridge.

The two existing bridges would remain in in operation until the new bridges are opened to traffic. The fate of the two existing bridges will be determined in the detailed design phase, but for now it is assumed that they would be closed to traffic and demolished once the new bridges are opened. The USACE would need to determine the scrap value of the existing bridges during the detailed design phase.

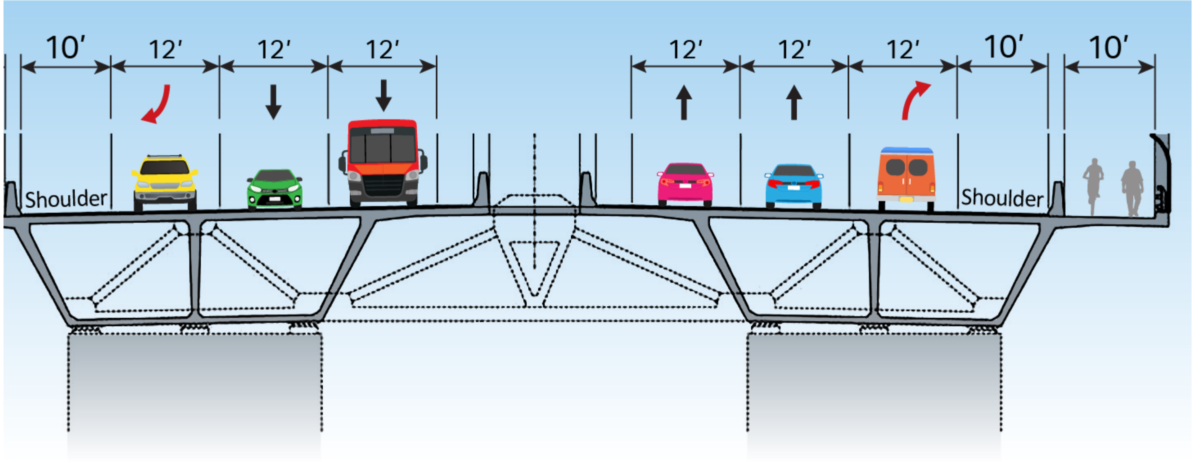
The recommended plan moving into the next phase of design analysis is replacement of each of the two highway bridges crossing the Cape Cod Canal FNP at Bourne and Sagamore. Final design would conform to AASHTO and MassDOT design standards current at that time. Subject to additional analysis during the next phase of the project the new bridges will have two through travel lanes and one acceleration/deceleration lane in each direction. The conceptual design evaluated at this stage of study consists of the following:

1) Construction of two new highway bridges each located parallel to and immediately inshore of the existing Bourne and Sagamore Bridges.
2) Each new bridge would include 4 through travel lanes (2 each direction 12 feet wide).

3) Each new bridge would have two auxiliary lanes for entrance and exit, one in each direction, each 12 feet wide.
4) Each new bridge would have a minimum vertical clearance for navigation of 135 feet above mean high water over the width of the navigation channel, increased 7.8 feet for anticipated sea level change (high rate).
5) Each new bridge would have deck and approach grades of no steeper than 4%.
6) Each new bridge would include one non-vehicular lane for pedestrian and bicycle traffic with separation between the non-vehicular lane and the vehicle traffic lanes.
7) Each new bridge would include a shoulder on the vehicle deck, 10 feet wide, in each direction.
8) Each new bridge would include a median with barriers to separate northbound and southbound vehicular traffic.
9) A conceptual cable-stay design was used for this analysis, but actual bridge type and other design parameters will be developed in the next phase.
10) The existing bridges would remain in service (operated, maintained and repaired as needed) until the new bridges are opened to traffic.
11) The existing bridges would be demolished upon opening of the new bridges. The steel components would be scrapped. The method of demolition and removal would be determined during the next phase.
12) Licenses and easements for placing new electric transmission and telecommunications cables on the new bridges would need to be proposed by the utility owners and negotiated. Placement of new gas lines would not be allowed on the new bridges.
13) Detailed design features such as lighting, fire suppression, suicide prevention barriers, signage and pavement markings, traffic barriers and controls, etc., would be determined during the design phase of the project.

The concept-level cross section used in this analysis is shown in Figure ES-6.

Figure ES-6 – Deck Sections for Conceptual Replacement Bridge Design



The concept for replacement bridges used in this analysis would have two through travel lanes and one auxiliary entrance/exit lane in each direction. Shoulders would also be provided in each direction. A non-vehicle lane for pedestrians and bicycles would be included as would a median to separate directions of traffic.

Recommendation

The USACE has determined that there is sufficient justification for pursuing a program of bridge replacement for both the Bourne and Sagamore highway bridges over the Cape Cod Canal, Massachusetts Federal Navigation Project. An evaluation of costs and benefits indicates that the most cost effective long-term means of providing vehicular crossing of the Canal is replacement of both bridges with new bridges that conform to modern highway design standards. This recommendation considers both safety and reliability of the bridges and the waterway they cross for both surface vehicular and marine transportation. The next phase of the investigation will determine final bridge type and other detailed design parameters, with such further modifications thereto as in the discretion of the Chief of Engineers may be advisable.

The recommendations contained in this report reflect the information available at this time and current USACE Departmental policies governing formulation of individual projects. They do not reflect program and budgeting priorities inherent in the formulation of a national Civil Works construction program nor the perspective of higher review levels within the Executive Branch. Consequently, the recommendations may be modified before they are approved for implementation funding.

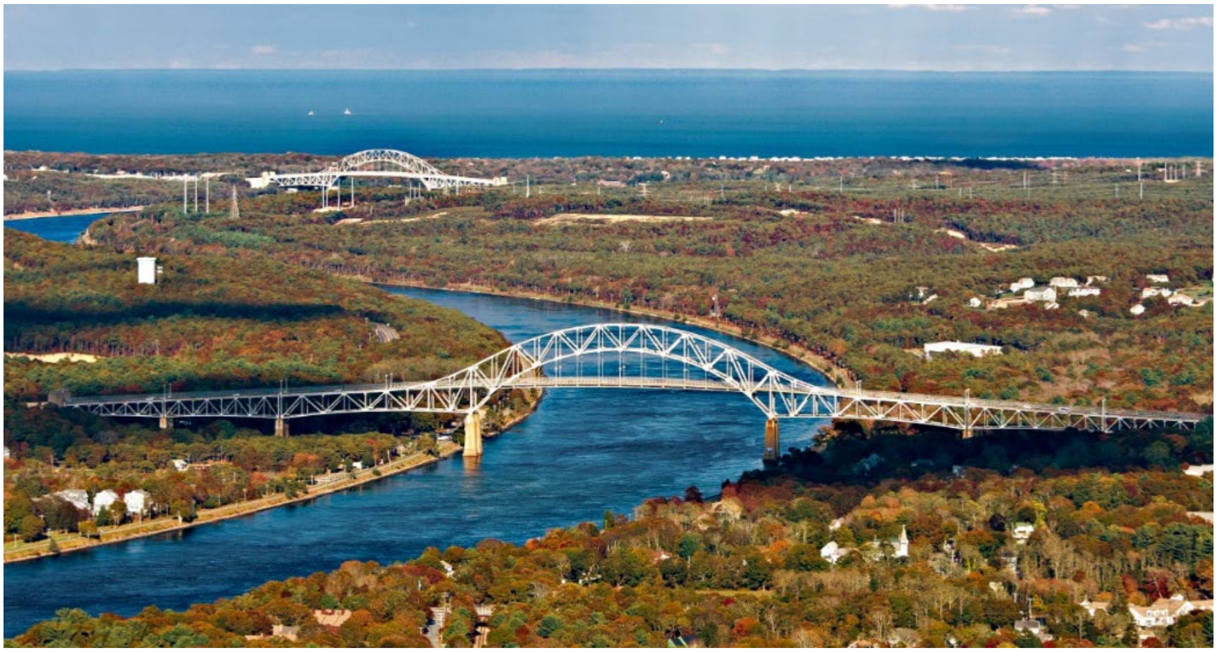


Figure ES-7 – Looking Northeast at the Bourne (foreground) and Sagamore Highway Bridges

This Page Intentionally Left Blank

Cape Cod Canal Highway Bridges
Bourne, Massachusetts
Major Rehabilitation Evaluation Report

Table of Contents

Page

1.0 INTRODUCTION 1
- 1.1 Project Location and Description 2
- 1.2 Project Authorization and History 4
- 1.3 Study Purpose and Scope 8
- 1.4 Project Sponsor 9
- 1.5 Study Participants and Coordination 10
- 1.6 Environmental Operating Principles 11
- 1.7 USACE Campaign Plan 11

2.0 PROBLEMS AND OPPORTUNITIES 13
- 2.1 Project Navigation Use 14
- 2.2 Bridge Traffic 15
- 2.3 Problems 17
- 2.4 Opportunities 17

3.0 IDENTIFICATION OF ALTERNATIVES 18
- 3.1 Alternatives in General 18
- 3.2 Federal Base Condition – Without Project Condition – Continued Maintenance and Repairs to Both Existing Bridges 21
- 3.3 A Program of Repairs and Major Rehabilitation for Both Bridges 21
- 3.4 Replacement of One or Both Highway Bridges with New Bridges 22
- 3.5 Replacement of Both Highway Bridges with a Single New Bridge 23
- 3.6 Replacement of One or Both High Bridges with Tunnels 24
- 3.7 Replacement of Both Bridges with a Single Tunnel 25
- 3.8 Replacement of One or Both Bridges with Low Level Draw Spans 26
- 3.9 Replacement of Both Bridges with Low Level Causeways 26
- 3.10 Deauthorization and Closure of the Cape Cod Canal 27
- 3.11 Deauthorization and Closure of the Cape Cod Canal 27
- 3.12 Screening of Initial Alternatives 27
- 3.13 Alternative Plans Carried Forward for Detailed Analysis 34

4.0 PROJECT BASELINE – THE EXISTING HIGHWAY BRIDGES 35
- 4.1 The Existing Bridges in General 35
- 4.2 Bridge Maintenance and Repair History and Costs 36
- 4.3 Current Condition and Reliability Analysis – Methodology 41
- 4.4 Current Physical Condition of the Highway Bridges 42
  - 4.4.1 Criteria and Condition Ratings 42
  - 4.4.2 Bourne Bridge Physical Condition 44
  - 4.4.3 Sagamore Bridge Physical Condition 45
  - 4.4.4 Fatigue Analysis Summary 46

4.4.5 Corrosion Analysis Summary 46
4.5 Base Condition Fix-as-Fails Actions and Costs 47
4.6 Base Condition Traffic Impacts 48

5.0 STRUCTURAL RELIABILITY ANALYSIS 49
5.1 Reliability Concepts 49
5.2 Deterioration Models 49
5.3 Reliability of Alternatives 50
5.4 Consequence of Unsatisfactory Performance 52
5.5 Results of Reliability Analysis 52

6.0 MAJOR REHABILITATION 54
6.1 The Major Rehabilitation Alternative in General 54
6.2 Major Rehabilitation Actions 55
6.3 Service Disruptions and Emergency Repairs 58
6.3.1 Vehicular Traffic Management during Major Rehabilitation 58
6.3.2 Navigation Traffic Management during Major Rehabilitation 59

7.0 BRIDGE REPLACEMENT ALTERNATIVES 60
7.1 Bridge Replacement in General - Concept Level Alternatives 60
7.2 Sea Level Change Impacts on New Bridge Design 62
7.2.1 Canal Water Levels and Datum 62
7.2.2 Sea Level Change 63
7.3 Bourne Bridge Replacement 66
7.4 Sagamore Bridge Replacement 66
7.5 Bridge Replacement Costs 67
7.5.1 New Highway Bridge Construction Costs 67
7.5.2 Associated State Highway Modifications 68
7.5.3 Real Estate Interests and Utility Relocation Costs 69
7.6 Traffic Management during Bridge Replacement 70
7.6.1 Vehicular Traffic Management during Bridge Replacement 70
7.6.2 Marine Traffic Management during Bridge Replacement 70
7.7 Future Operation, Maintenance and Repair Costs for Replacement Bridges 71

8.0 ECONOMIC ANALYSIS 71
8.1 Federal Interest 71
8.2 Overview of Economic Analysis Methodology 72
8.2.1 Economic Methodology 72
8.2.2 Discounting and Period of Analysis 73
8.3 Base Condition – Alternative A – Fix-as-Fails 73
8.3.1 Probability of Unsatisfactory Performance – Base Condition 74
8.3.2 Probabilistic Analysis – Base Condition 74
8.3.3 Traffic Data Collection and Analysis – Base Condition 77
8.3.4 Impacts to Navigation – Base Condition 77
8.3.5 Annual Maintenance Costs – Base Condition 78
8.3.6 Summary of Future Without-Project Condition – Base Condition 79

8.4 Alternative B – Major Rehabilitation 79
  8.4.1 Probability of Unsatisfactory Performance – Major Rehabilitation 80
  8.4.2 Results of Monte Carlo Simulation – Plan B 81
  8.4.3 Cost of Major Rehabilitation 82
  8.4.4 Annual Costs of Major Rehabilitation 83
  8.4.5 Major Rehabilitation – Results of Economic Analysis 84
  8.4.6 Summary of the Major Rehabilitation Alternative 84
8.5 Alternative D – Replacement with 4 Lanes and 2 Auxiliary On/Off Lanes 85
  8.5.1 Probability of Unsatisfactory Performance 86
  8.5.2 Benefits, Unsatisfactory Performance, and Monte Carlo Simulation 87
  8.5.3 Benefits of Reduced Congestion – Plan D 88
  8.5.4 Cost of Bridge Replacement Plan D 89
  8.5.5 Future Traffic Delay Cost with Bridge Replacement Plan D 90
  8.5.6 Total Annualized Cost – Plan D Bridge Replacement 90
  8.5.7 Replacement Bridge – Results of Economic Analysis 91
  8.5.8 Summary of New Bridge Replacement Plan D 92
8.6 Extended Life Value of New Bridges 92
8.7 Summary of Economic Results and Conclusions 92

9.0 ENVIRONMENTAL CONSIDERATIONS AND ANALYSIS 94
9.1 Affected Environment and Environmental Consequences 94
  9.1.1 Land Use 94
  9.1.2 Terrain and Topography 95
  9.1.3 Geology and Soils 95
  9.1.4 Climate 96
  9.1.5 Air Quality 96
  9.1.6 Lead Paint 97
  9.1.7 Surface Water and Wetlands 97
  9.1.8 Water Quality 98
  9.1.9 Groundwater 98
  9.1.10 Floodplains 99
  9.1.11 Coastal Zone 99
  9.1.12 Coastal Barrier Resource System 99
  9.1.13 Vegetation 100
  9.1.14 Wildlife 100
  9.1.15 Fisheries, Marine Wildlife and Essential Fish Habitat 101
  9.1.16 Threatened and Endangered Species 102
  9.1.17 Environmental Justice 103
9.2 Indirect Impacts 104
  9.2.1 Induced Development 105
  9.2.2 Traffic Impacts 105
  9.2.3 Population Models and Forecasted Growth 105
9.3 Cumulative Impacts 106
9.4 Public Involvement 107
9.5 Environmental Coordination 108

10.0 CULTURAL RESOURCE CONSIDERATIONS AND ANALYSIS 109
- 10.1 General Cultural Resource Concerns 109
- 10.2 Cultural Resource Impacts 110
- 10.3 Cultural Resource Coordination 110
- 10.4 Cultural Resource Recommendations 111

11.0 OTHER SOCIAL EFFECTS ANALYSIS 111
- 11.1 Background and Purpose 111
- 11.2 Community Characteristics 112
  - 11.2.1 Population Size and Composition 112
  - 11.2.2 Population Structure and Diversity 114
  - 11.2.3 Employment and Industry 114
- 11.3 Alternatives: Consequences to Community Characteristics 115
- 11.4 Baseline OSE Factors and Conditions for Cape Cod and the Islands 116
  - 11.4.1 Health and Public Safety 116
- 11.5 Economic Vitality 119
- 11.6 Social Connectedness 121
- 11.7 Identity 122
- 11.8 Social Vulnerability 123
- 11.9 Participation 123
- 11.10 Leisure and Recreation 124

12.0 REAL ESTATE CONSIDERATIONS AND ANALYSIS 125
- 12.1 Existing Federal Lands and Interests 125
- 12.2 Land Use and Potential Impacts 126
- 12.3 Lands, Easements and Rights of Way Required 126
- 12.4 Utility Relocations 128
- 12.5 LERR Costs 130

13.0 ASSESSMENT OF ALTERNATIVES 131
- 13.1 Risk Assumptions and Variables 132
- 13.2 Reliability Changes with Alternatives 132
- 13.3 Opportunity Costs during Repair and Rehabilitation 133
- 13.4 Opportunity Costs during Replacement 133
- 13.5 Cost of Alternatives 133
- 13.6 Comparison of Alternatives 134
- 13.7 Value Engineering 136

14.0 THE RECOMMENDED PLAN 136
- 14.1 Description of the Recommended Plan 136
- 14.2 Outputs of the Recommended Plan 139
- 14.3 Impacts of the Recommended Plan 140
- 14.4 Non-Federal Requirements for the Recommended Plan 141
- 14.5 Project Operations and Maintenance Manual 142
- 14.6 Project Management Plan 142

15.0 MAJOR REHABILITATION CLASSIFICATION 142

16.0 PROJECT COST SUMMARY 142

17.0 SUMMARY AND CONCLUSIONS 145

18.0 RECOMMENDATION 146

ENVIRONMENTAL ASSESSMENT

FINDING OF NO SIGNIFICANT IMPACT

REFERENCES

APPENDICES

APPENDIX A – Engineering Reliability Analysis
APPENDIX B – Project Authorization and Work History
APPENDIX C – Cost Engineering
APPENDIX D – Economic Evaluation
APPENDIX E – Agency Coordination
APPENDIX F – Public Involvement
APPENDIX G – Natural Resources Conservation Service - Soils
APPENDIX H – Coastal Zone Management – Preliminary Consistency Determination
APPENDIX I – USF&WS IPAC Species List
APPENDIX J – Real Estate

TECHNICAL SUPPORTING DOCUMENTS

1 MassDOT Cape Cod Canal Transportation Study – Draft Summer 2019
2 Cultural Resources Identification and Evaluation – Stantec for MassDOT – May 2017
3 MA DFW Natural Heritage & Endangered Species Program – BioMap2 – Habitat List – Bourne - 2012

List of Figures

		Page
1	Cape Cod Canal Project Location and Navigation Routes	3
2	Existing Federal Navigation Project	4
3	Bridge and Approach Ownership Responsibility	9
4	Cape Cod and Islands over Water Transportation Links	13
5	Deck Section for Existing Bridges	16
6	Alternatives – Single Third Bridge or Single Tunnel	24
7	Alternatives C and D – Replacement of Both Existing Bridges	29
8	Major Bridge Components – Bourne Bridge – Superstructure	37
9	Major Bridge Components – Bourne Bridge – Substructure and Deck	42
10	History of Condition Ratings – Bourne Bridge	44
11	History of Condition Ratings – Sagamore Bridge	45
12	Example Weibull CDF and Hazard Rates – Base Condition	51
13	Event Tree Examples – Sagamore Bridge – Base Condition	53
14	Concept Level Siting Areas for Replacement Bridges	61
15	Relative Sea Level Trend at Woods Hole, Massachusetts – NOAA	64
16	Relative Sea Level Change Curves – USACE	65
17	Canal Area State Proposed Highway Improvements	69
18	Probability of Failure – Base Condition – Existing Bridges	75
19	Probability of Unsatisfactory Performance Bridge Superstructures	80
20	Bridge Replacement Failure Probability – Bridge Superstructure	87
21	CEDS Stakeholder Survey	111
22	Barnstable County Summer Population	113
23	Number of Monthly Crashes within One Mile of the Bridges (2010-2014)	118
24	USACE Real Estate Holdings – Cape Cod Canal FNP	125
25	Bridge Study Area – Sagamore Bridge	127
26	Bridge Study Area – Bourne Bridge	128
27	General Locations for Bridge Replacement	138
28	Deck Sections for Conceptual Replacement Bridge Design	138

List of Tables

		Page
1	Canal Vessel Traffic – 2013 to 2017	14
2	Canal Cargo Vessel Traffic – 2012 to 2016	15
3	Canal Waterborne Commodities Carried – 2012-2016	15
4	List of Alternatives	20
5	Initial Screening Summary	34
6	List of Alternatives Carried Forward for Detailed Analysis	35
7	Existing Highway Bridge Design Dimensions	37
8	Bourne Bridge Maintenance and Repair History	38
9	Sagamore Bridge Maintenance and Repair History	39
10	Recent Operation and Maintenance Costs for the Two Highway Bridges	41
11	Bridge Condition Ratings	43
12	Bourne Bridge Component Condition Ratings	45
13	Sagamore Bridge Component Condition Ratings	46

14 Base Condition – Potential Repair Actions and Costs 47
15 Base Condition Traffic Impacts 48
16 Base Condition – Repair and Traffic Delay Costs 52
17 Major Rehabilitation Costs – Bourne and Sagamore Bridges 57
18 Anticipated Traffic Management Requirements for Lane and Bridge Closures 59
19 Canal Tidal Datum in Feet Relative to Mean Sea Level – NOAA 63
20 USACE Relative Sea Level Change Predictions 65
21 Project Costs – Bridge Replacement Alternatives 68
22 Base Condition – Repair and Traffic Delay Costs 76
23 Annual Costs – Base Condition 79
24 Annual Cost & Benefits – Major Rehabilitation 81
25 Major Rehabilitation Design and Construction Costs 82
26 Rehabilitation Construction and Travel Costs 83
27 Major Rehabilitation – Total Annualized Costs 84
28 Annual Rehabilitation Costs and BCR 85
29 Bridge Replacement 6 Lanes – Annual Costs 88
30 Benefits of Reduced Congestion - Bridge Replacement – Plan D 88
31 Bridge Replacement 6 Lanes – Benefits 89
32 Bridge Replacement Construction Costs – Plan D 89
33 Bridge Replacement 6 Lanes – Costs 90
34 Bridge Replacement 6 Lanes Total Annualized Cost 91
35 Bridge Replacement 6 Lanes Annual Cost and BCR 91
36 Economic Summary Results – Sagamore and Bourne Bridge Replacement 93
37 Total Population – Cape Cod and Islands 112
38 Proportion of Seasonal-Use Houses 113
39 Age and Ethnicity – Cape Cod and Islands 114
40 Employment Proportion by Industry – Cape and Islands 115
41 Travel Impact – 2015 (U.S. Travel Association 2016) 119
42 Steamship Authority Ridership 2015 (Steamship Authority 2016) 121
43 Utility Licenses Over or Near Bridges 129
44 LERR Costs – Plans C and D Replacement 130
45 Cumulative Reliability Improvements for Alternatives (at Year 50) 132
46 Major Rehabilitation Lane and Bridge Closure Durations 133
47 Sagamore Bridge Summary Benefit-Cost Analysis Results 134
48 Bourne Bridge Summary Benefit-Cost Analysis Results 135
49 Comparison of Rehabilitation and Replacement Plans 139
50 Implementation Costs for the Recommended Plan – Plan D 143
51 Fully-Funded Implementation Costs for the Recommended Plan – Plan D 144

Acronyms Used in this Report and the Environmental Assessment

Acronym	Meaning
AADT	Annual Average Daily Traffic
AASHTO	American Association of State Highway Transportation Officials
ACEC	Area of Critical Environmental Concern
ACHP	Advisory Council on Historic Preservation
ANG	Massachusetts Air National Guard
BMP	Best Management Practices
BP	Before Present
CAA	Clean Air Act
CEQ	White House Council on Environmental Quality
CFR	Code of Federal Regulations
CBRA	Coastal Barrier Resources Act (1982)
CEDS	Comprehensive Economic Development Strategy – CC Commission
CWA	Clean Water Act
CY	Cubic Yards
CZM	Coastal Zone Management
EA	Environmental Assessment
EFH	Essential Fisheries Habitat
EFLD	Eastern Federal Lands Division of the FHWA
EIS	Environmental Impact Statement
ELT	Executive Leadership Team (USACE, FHWA and MassDOT)
ESA	Endangered Species Act
EO	Executive Order
EP	USACE Engineering Pamphlet
EPA	Environmental Protection Agency
ER	USACE Engineering Regulation
ETL	USACE Engineering Technical Letter
FCM	Fracture Critical Member
FCSA	Feasibility Cost-Sharing Agreement
FEMA	Federal Emergency Management Agency
FHWA	Federal Highway Administration (sometimes FHWA)
FIRM	Flood Insurance Rate Map
FNP	Federal Navigation Project
FONSI	Finding of No Significant Impact
FR	Federal Register
FSD	Fatigue Sensitive Details
FY	Federal Fiscal Year (1 October to 30 September)
GNF	General Navigation Features
HQUSACE	Headquarters, U.S. Army Corps of Engineers
IAA	Interagency Agreement
IPaC	Information for Planning and Conservation (USF&WS)
IWR	Institute for Water Resources

Acronym	**Meaning**
JBCC	Joint Base Cape Cod
LERRD	Lands, Easements, Rights-of-Way, Relocations and Dredged Material Placement Areas
MassDOT	Massachusetts Department of Transportation
MA DEP	Massachusetts Department of Environmental Protection
MA DFG	Massachusetts Department of Fish and Game
MA DFW	Massachusetts Division of Fisheries and Wildlife
MA DMF	Massachusetts Division of Marine Fisheries
MA NHESP	Massachusetts Natural Heritage Endangered Species Program
MBE	Manual for Bridge Evaluation
MBTA	Migratory Bird Treaty Act
MSA	Magnusson-Stevens Fishery Conservation and Management Act
MHW	Mean High Water
MLLW	Mean Lower Low Water
MLW	Mean Low Water
MOU	Memorandum of Understanding (USACE and MassDOT)
MPO	Metropolitan Planning Organization (Cape Cod Regional)
MRER	Major Rehabilitation Evaluation Report
NAAQS	National Ambient Air Quality Standards
NAD	North Atlantic Division, Corps of Engineers
NAE	New England District, Corps of Engineers
NBIS	National Bridge Inspection Standards
NCHRP	National Cooperative Highway Research Program
NEPA	National Environmental Policy Act
NESHAP	National Emission Standards for Hazardous Air Pollutants
NFIP	National Flood Insurance Program
NHPA	National Historic Preservation Act
NLEB	Northern Long-Eared Bat
NMFS	National Marine Fisheries Service
NPDES	National Pollutant Discharge Elimination System
NRHP	National Register of Historic Places
NWI	National Wetlands Inventory
OMRR&R	Operation, Maintenance, Repair, Replacement and Rehabilitation
OSE	Other Social Effects
PGN	Planning Guidance Notebook (USACE ER 1105-2-100)
PPA	Project Partnership Agreement
PPM/PPB/PPT	Parts per Million/Billion/Trillion
REPR	Real Estate Planning Report
SHPO	State Historic Preservation Officer
SLR/SLC	Sea Level Rise/Sea Level Change
THPO	Tribal Historic Preservation Officer
UMass	University of Massachusetts
USACE	U.S. Army Corps of Engineers

Acronym	Meaning
USCG	U.S. Coast Guard
USDA	U.S. Department of Agriculture
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey (Department of the Interior)
VE	Value Engineering
VMT	Vehicle Miles Travelled
WCSC	Waterborne Commerce Statistics Center (at IWR)
WHG	Woods Hole Group
WIIN	Water Infrastructure Improvements for the Nation Act (Dec 2016)
WQC	Water Quality Certification
WRDA	Water Resources Development Act
WRRDA	Water Resources Reform and Development Act (June 2014)

CAPE COD CANAL HIGHWAY BRIDGES
MASSACHUSETTS
MAJOR REHABILITATION EVALUATION REPORT

1.0 INTRODUCTION

This report examines the two high level fixed span highway bridges, the Bourne and Sagamore, that cross the Cape Cod Canal and are part of the authorized Cape Cod Canal Federal Navigation Project (FNP) operated and maintained by the U.S. Army Corps of Engineers (USACE), New England District (NAE). The USACE completes a Major Rehabilitation Evaluation Report (MRER) whenever infrastructure maintenance construction costs are expected to exceed $20 million and take more than two years of construction to complete. The MRER is based on a four-part evaluation: a structural engineering risk and reliability analysis of the current structures, cost engineering, economic analysis, and environmental evaluation of all feasible alternatives. An MRER identifies operational and potential reliability issues, as well as opportunities for efficiency improvement, over a 50-year period of analysis.

The two steel truss bridges have been in service about 85 years since their original completion in 1935 and are both nearing their second major rehabilitation. The first rehabilitation occurred in 1980 when the bridges were 45 years old, and the next is due to begin in about five years. The age of the bridges, their dimensions relative to modern highway design requirements, and increasing costs of maintenance and repairs necessitate a close examination of major rehabilitation needs and costs over the coming years compared to reasonable alternatives, including replacement of one or both bridges. This report will examine the existing bridges, their authorization, present condition, current and long-term future maintenance and repair needs, changes in traffic conditions, and alternative means of providing a safe and cost-effective vehicular connection between the Cape and Islands communities and the mainland.

This Major Rehabilitation Evaluation Report and its accompanying NEPA document are the first phase in examining the future of the Cape Cod Canal Highway Bridges. This phase will examine whether standard operation and maintenance, a program of repair and major rehabilitation, or replacement of one or both bridges, will provide the most reliable fiscally responsible solution. The report will investigate the problem, develop and evaluate potential alternatives, screen-out less practicable alternatives, and recommend the most cost-effective course of action for meeting future needs.

The alternatives developed and evaluated in this study are at a concept level. Assumptions have been made for the purposes of conducting the evaluations presented at this phase, including cost estimates, and general impact areas for new crossings. However no decisions will be made at this phase on issues such as: future limits on traffic over the existing bridges, the specific alignment of any new crossing, any specific type of new bridge, the fate of the existing bridges should new crossings be built, the extent of any real estate acquisition, and other design details such as types and extent of pedestrian and bicycle crossings, roadway grades, utility relocations, construction methods, and navigation clearances.

The two existing bridges are coming up on their second major rehabilitation. Unless alternatives are implemented, upcoming rehabilitation of the Sagamore Bridge would be scheduled for 2025-2027 and cost about $185 million, and the next work on the Bourne Bridge in 2029-2031 at a cost of about $210 million. A program of critical repairs requiring extensive lane closures may be able to delay the full rehabilitation starts by a few years, but if bridge replacement is recommended any more of a delay in implementing that work would require rehabilitation to proceed.

The Commonwealth of Massachusetts would be a necessary partner in any rehabilitation or replacement project. However the State's principal role would involve redesign and relocation of connecting highways and roadways if bridge replacement is pursued. The State has made a capital investment of $10 million dollars to begin environmental coordination and early design work for adjacent infrastructure and new bridge approaches in 2020. Additionally, the Commonwealth has proposed more than $350 million dollars in its 2019 transportation bond bill for the planning, study, design and construction of transportation infrastructure associated with the approaches to the Bourne and Sagamore Bridge as a part of the Cape Cod Bridges Improvement program within the *Act Authorizing and Accelerating Transportation Investment*, Section 2A, 6121-2147. Any delays in Federal funding could put that commitment and that work in question. There is a level of urgency in Federal and State decision making concerning the recommendation and funding to implement it. This report will outline and clarify the issues involved and aid in the decision making process at all levels.

The documents include this Major Rehabilitation Evaluation Report (MRER), an accompanying Environmental Assessment (EA) necessary to make a risk informed decision, and several appendices providing greater detail on certain topics. A number of additional technical supporting documents (TSD), while not a part of the report, are included in the record as reference material.

1.1 Project Location and Description

The Cape Cod Canal, as shown in Figure 1, is located in Barnstable County, Massachusetts, about 47 miles south of Boston and about 190 miles east of New York City. The Canal provides a shortened sea route connecting Buzzards Bay in the southwest with Cape Cod Bay in the northeast, avoiding the longer route around Cape Cod, the Islands of Martha's Vineyard and Nantucket, Nantucket Shoals and Georges Bank.

The Canal's purpose is to provide a shorter, inshore, and more protected route between northern and eastern New England ports and those of southern New England, New York and points further south along the Atlantic coast. The distance between the deep water shipping lanes off Rhode Island Sound south of Block Island and Montauk, and the outer approaches to Boston Harbor is only 145 nautical miles (NM) by the Canal, as compared to 262 NM if travelling around the Cape, Islands, and Nantucket Shoals, a savings of about 117 NM. Even for smaller boats that can traverse the shallower waters of Nantucket Sound the difference is a savings of about 45 NM (190-145). This is a significant savings in time and cost for all classes of vessels that can use the Canal's 32-foot deep channel.

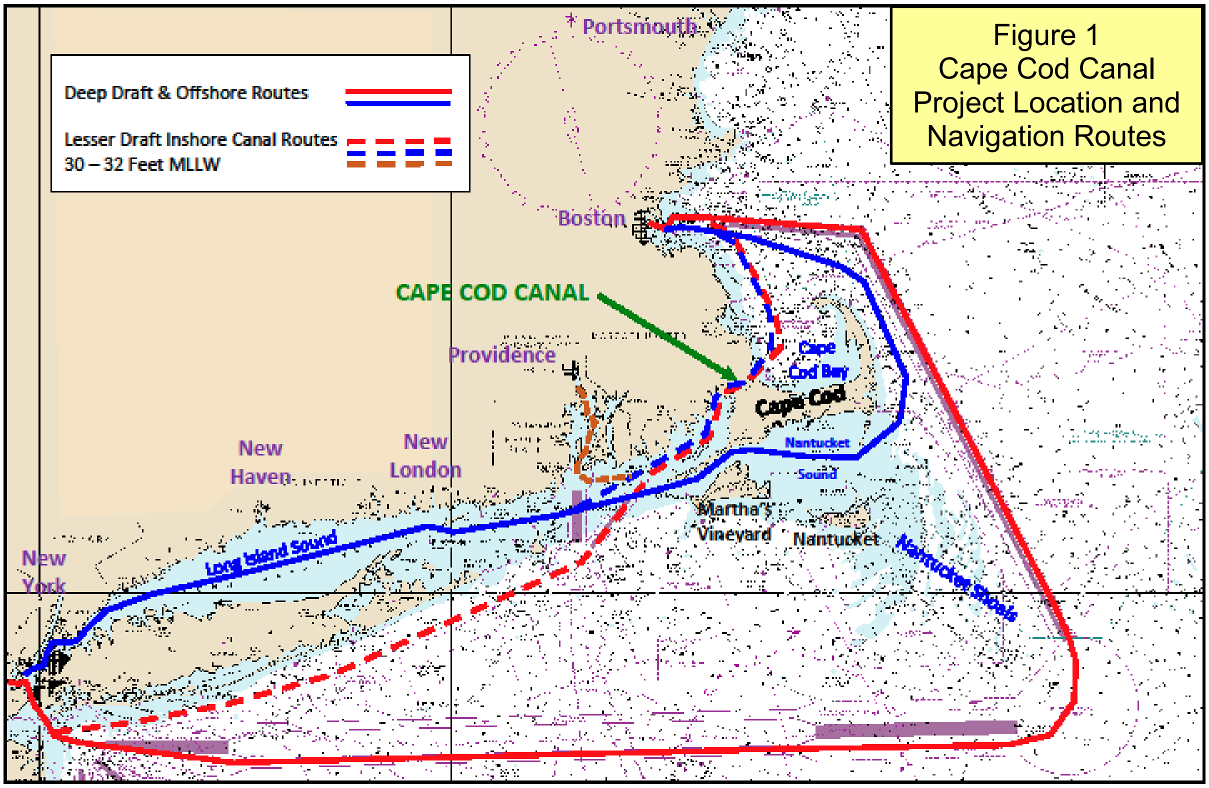


Figure 1
Cape Cod Canal
Project Location and
Navigation Routes

The Cape Cod Canal Federal Navigation Project consists of the dredged approach channels from both bays, maneuvering and mooring areas at each end of the Canal, the 7.7-mile long land cut of the Canal, jetties and training dikes, revetments, railroad and highway bridges crossing the Canal, 10 recreational areas along the canal, access roads, traffic management facilities, visitor center, a small boat harbor, and other appurtenant works. Federally owned lands administered by the USACE total 1,153 acres. The project features are shown in Figure 2. The project is located in the Massachusetts 9th Congressional District.

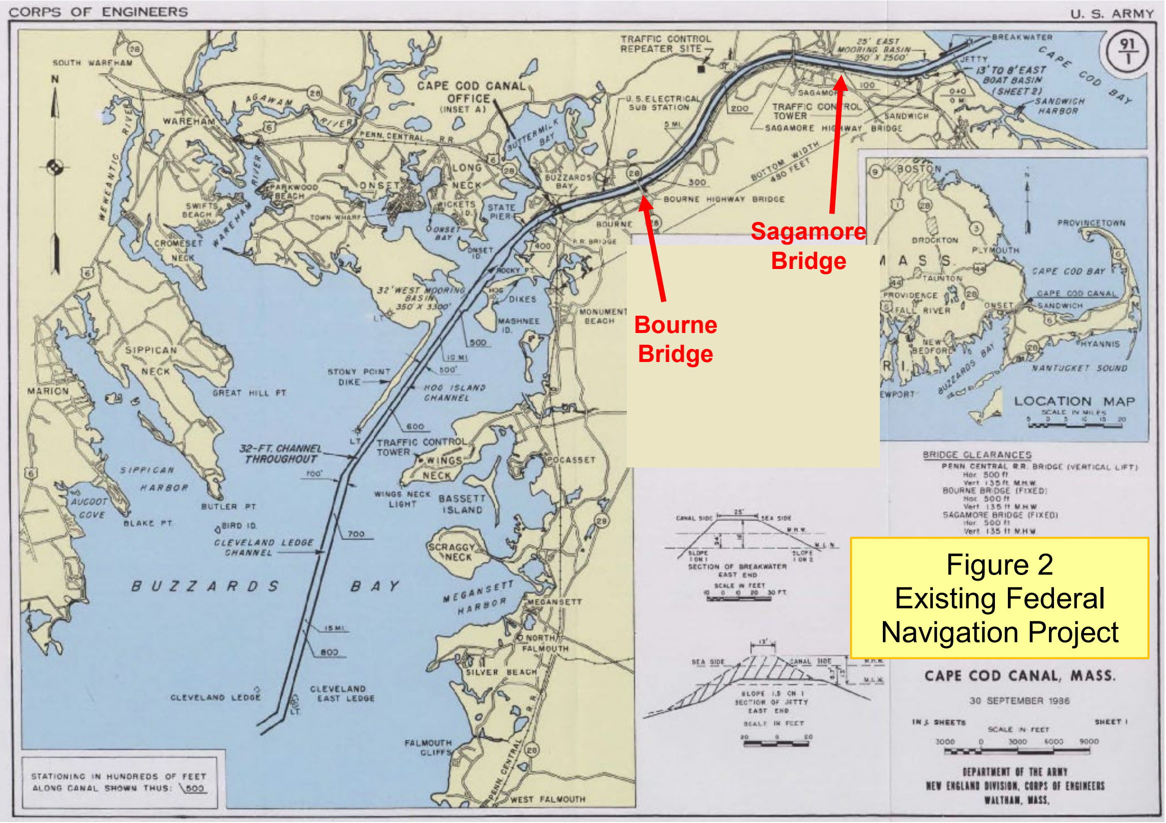

CORPS OF ENGINEERS
U. S. ARMY
91
1
Sagamore Bridge
Bourne Bridge
CAPE COD CANAL OFFICE (INSET A)
TRAFFIC CONTROL REPEATER SITE
U.S. ELECTRICAL SUB STATION
TRAFFIC CONTROL TOWER
SAGAMORE HIGHWAY BRIDGE
BOURNE HIGHWAY BRIDGE
BOTTOM WIDTH 480 FEET
25' EAST MOORING BASIN 350' X 2500'
13' TO 8' EAST BOAT BASIN (SHEET 2)
SANDWICH HARBOR
BREAKWATER
JETTY
CAPE COD BAY
32' WEST MOORING BASIN 350' X 3300'
32-FT. CHANNEL THROUGHOUT
HOG ISLAND CHANNEL
CLEVELAND LEDGE CHANNEL
BUZZARDS BAY
WAREHAM
ONSET
MARION
SIPPICAN NECK
WINGS NECK
SCRAGGY NECK
MEGANSETT HARBOR
FALMOUTH CLIFFS
WEST FALMOUTH
CLEVELAND LEDGE
CLEVELAND EAST LEDGE
STATIONING IN HUNDREDS OF FEET ALONG CANAL SHOWN THUS: 500
LOCATION MAP
BRIDGE CLEARANCES
PENN CENTRAL R.R. BRIDGE (VERTICAL LIFT) Hor. 500 ft Vert. 135 ft M.H.W.
BOURNE BRIDGE (FIXED) Hor. 500 ft Vert. 135 ft M.H.W.
SAGAMORE BRIDGE (FIXED) Hor. 500 ft Vert. 135 ft M.H.W.
SECTION OF BREAKWATER EAST END
SECTION OF JETTY EAST END
CAPE COD CANAL, MASS.
30 SEPTEMBER 1986
IN 2 SHEETS
SHEET 1
SCALE IN FEET
DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASS.

Figure 2
Existing Federal
Navigation Project

1.2 Project History and Authorization

The route of the present Cape Cod Canal between the heads of Cape Cod Bay and Buzzards Bay was a trade route in colonial times as far back as the 1620s. The Massachusetts Bay Colony and later the Commonwealth of Massachusetts repeatedly studied the idea of a canal in the 1690s, 1770s, 1790s, and through much of the 19th Century. The earliest reports of surveys for a canal route by the Corps of Engineers were published in the 1820s, 1870, and in the 1880s through 1913. Appendix B – Project History, contains a more detailed presentation of the project's history and development.

By the mid 1800's proposals for a canal had settled on a preferred route from the head of Buzzards Bay east to Cape Cod Bay. The Canal would follow the valley of the Monument River from the west and portions of the Scusset River from the east. While deep water in Cape Cod Bay was available less than two miles from the Canal's eastern entrance, corresponding depths in Buzzards Bay were more than ten miles from the mouth of the Monument River requiring a lengthy western approach channel.

The Commonwealth of Massachusetts twice granted charters to private companies for construction and operation of a Canal. The first of these in 1883 began dredging a channel at the Cape Cod Bay end but quickly exhausted its funding and ceased work. In 1899 a charter was issued to the Boston, Cape Cod and New York Canal Company. Under that charter and three later legislative amendments the company began construction in 1909 and opened the canal to shallow-draft traffic drawing up to 12 feet in 1914. Further dredging gradually increased the depth to 25 feet by 1916, though final completion of all approaches and other features was not achieved until January 1918.

Under the state charter the Canal Company was required to construct and maintain bridges over the canal serving both Bourne and Sandwich (or ferries or tunnels) as determined by the state and county as necessary to replace roads cut by construction of the canal. The Company would build two highway bridges, at Buzzards Bay in Bourne at the west end of the Canal, and at Sagamore near Sandwich at the east end. A railroad bridge was also built at Buzzards Bay and a ferry crossing established at Bournedale about mid-way along the canal land cut. All three bridges were low level draw spans.

Beginning in 1913 Congress again took interest in the Cape Cod Canal and other east coast canals. In 1913 the USACE prepared a report on Federal improvement of the canal's western approaches through Buzzards Bay. In 1915 a report was prepared examining small craft harbor improvements at Onset Bay at the canal's western entrance.

In 1918 a more comprehensive report (see Senate Document #279, 65th Congress, 2d Session) was prepared examining Federal acquisition and improvement of three east coast canals, including the Cape Cod Canal, as World War I elevated concern over risks to coastal shipping from enemy attack on the Atlantic seaboard. That report states that on 22 July 1918 possession of the Cape Cod Canal was placed under the control of the Director General of Railroads by a Presidential Proclamation 1419, 26 December 1917 (40 Stat. 1808), and that operation of the canal was entrusted to the United States Railroad Administration (USRA). These actions were taken under authority in Section 1 of the Army Appropriations Act of 29 August 1916 (39 Stat. 645) which gave the President power, in time of war, *"to take possession and assume control of any system or systems of transportation… for the transfer or transportation of troops, war material and equipment, or for such other purposes connected with the emergency …"*. The USRA operated the Canal and proceeded with maintenance dredging of the Canal to return its controlling depth to the 25-foot design depth. The railroads and other seized properties and concerns were returned to private control on March 1, 1920. Congress however was concurrently examining Federal acquisition of both the Cape Cod and the Chesapeake and Delaware canals, and called for additional studies.

In 1919 Congress authorized purchase of the Cape Cod Canal, not to exceed $10 million, and the Government began condemnation proceedings. In 1921 the Secretary of War and the Canal Company agreed on a price of $11.5 million, including $6 million on the value of the Company's outstanding bonds. The agreement was then presented to Congress for approval and action. Between 1921 and 1927 Congress repeatedly took up the issue of purchasing the Canal and a number of committee reports were published describing the course of debate.

The River and Harbor Act of 21 January 1927, Section 2 (44 Stat. 1010, P.L. 69-560) ratified the contract for purchase of the Canal. The purchase price remained $5.5 million cash, plus $6 million for principal and interest on the bonds, as specified in House Document #719, 69th Congress, 2d Session, 15 February 1927. Two Appropriations Acts for Fiscal Year 1928 provided the funds (45 Stat. 2, P.L. 70-2 and 45 Stat. 883, P.L.70-563), as specified in House

Document #221, 70th Congress, 1st Session, 10 April 1928. Title to the Canal passed to the Government on 1 January 1929, although the Government had assumed control and operation of the Canal on 31 March 1928. At that time tolls ceased and the Corps began operation of the canal, bridges and ferry.

The River and Harbor Act of 3 July 1930 (46 Stat. 918, P.L. 71-520) directed another study be made of the Cape Cod Canal. The reports of the preliminary examination and survey report are printed in House Document #795, 71st Congress, 3d Session, 3 March 1931, with a recommendation for improving the Canal that included the following: channel depth of 30 feet, channel widths of 250 feet in the land cut and 400 feet in the approaches, widened to 700 feet in Buzzards Bay, a new railroad draw span to accommodate the widened channel, a single high level fixed span highway bridge to replace the two draw spans, a small craft harbor at Onset Bay, and elimination of the Bournedale ferry (it would cease operation in 1932).

The National Industrial Recovery Act of 1933 (P.L. 73-67) was enacted to "encourage national industrial recovery, foster fair competition and for construction of certain public works." Title II authorized the President to create new agencies, specifically the Federal Emergency Administration of Public Works (the Public Works Administration). The PWA would be used to initially authorize improvements to the Cape Cod Canal, including three new bridges (two highway and one railroad) and the deepening and widening of the channel. Beginning in 1933 the USACE used PWA appropriations to construct these improvements. Construction of the two existing highway bridges at Bourne and Sagamore began in December 1933. The bridges were completed in 1935, using funding provided in the Emergency Relief Appropriations Act, 74th Congress, 1st Session, 8 April 1935.

While bridge construction and other work was ongoing Congress requested another report on improvements to the Canal. Reports printed in House Committee on Rivers and Harbors Document #15, 74th Congress, 1st Session, 26 December 1934, recommended modification to plans presented in 1931. Elimination of the tidal lock and a sea level channel with a depth of 32 feet with a land cut 540 feet wide and widened approaches and larger mooring basins were now recommended. This report also states that *"the obligations imposed on the United States in acquiring the canal prevented the substitution of a single highway bridge for the two present crossing and two fixed highway bridges are therefore being constructed with a clear span of 550 feet and a vertical clearance of 135 feet above high water. A new railroad bridge with a vertical lift of 500 feet span, affording a clearance of 135 feet above high water is also being constructed"*.

The improvements recommended in HCR&H Document #15 were authorized by the River & Harbor Act of 30 August 1935, 74th Congress, 1st Session (P.L. 74-409). The recommendation was for "an open canal 32 feet deep, 540 feet wide in the land cut, 500 feet wide in the new straight channel to Wings Neck, and 700 feet wide beyond Wings Neck, a 15-foot channel into Onset Bay 100 feet wide, mooring basins at each end of the canal …. with operation, care and maintenance, which shall include maintenance of the new bridges now under construction." Construction of these improvements, some of which were already underway in 1935 using PWA funds would be completed in 1940. The final constructed mooring basin dimensions were: East Basin - 2,500 feet long by 350 feet wide by -25 feet

MLW, West Basin - 3,300 feet long by 350 feet wide by -32 feet MLW. Work of removing the three old draw span bridges and their piers began in June 1935 was completed by July 1936.

Ultimately two small boat harbors would be built, one at each end of the canal. The 15-foot Onset Bay channel was initially completed in Fiscal Year 1937. The channel entrance was realigned in 1940. In 1957 the Onset Bay channel was extended to the Town Wharf with a 15-foot turning basin and 8-foot anchorage, as authorized by the River and Harbor Act of 2 March 1945 (P.L. 79-14).

Construction of the 13-foot deep outer section of the East Boat Basin at Sandwich, and the 18-foot West Boat Basin at Bourne, was accomplished in 1938 to 1939. Expansion of the East Boat Basin by adding an inner 4.3-acre by -8-foot MLW area was completed in 1963, as authorized by the River & Harbor Act of 3 July 1958.

A third small boat harbor was authorized by the River and Harbor Act of 1948 and built in 1952-1953 at Buttermilk Bay in Bourne. The project consisted of a 7-foot entrance channel from the Canal into the lower portion of Buttermilk Bay. This project was modified under the Section 107 continuing authority in 1983 to extend the channel up to the highway bridge at 6 feet and into the Town marina basin at Taylor Point. Dredging and boulder removal for the channel extension was completed in 1984.

In summary authority for the construction of the existing bridges as part of the FNP stems from the original authorization for the Government's purchase of the Canal in the River and Harbor Act of 1927, the deed conveying the Canal and the bridges to the Government, and the expansion and deepening of the Canal with replacement of the bridges as authorized by the National Industrial Recovery Act of 1933. Maintenance of the bridges as part of the FNP was further authorized by the River and Harbor Act of 1935.

The America's Water Infrastructure Act of 2018, Title I – Water Resources Development, provides additional authority for USACE replacement of the Cape Cod Canal highway bridges. Section 1315 of the act, *Corps of Engineers bridge repair program for New England evacuation routes,* states the following:

> *Subject to the availability of appropriations, the Secretary may repair or replace, as necessary, any bridge owned and operated by the Secretary that is –*
> *(1) located in any of the States of Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, or Vermont; and*
> *(2) necessary for evacuation during an extreme weather event, as determined by the Secretary.*

The Cape Cod Canal highway bridges are the only hurricane evacuation routes off Cape Cod and the Islands. They are the only highway bridges owned and operated by the USACE in New England and so are the only bridges to which this legislative language applies.

Appendix B contains a more detailed and complete history of USACE studies, acquisition, improvement and maintenance of the Cape Cod Canal and its various project features. In summary the authority for the USACE to operate and maintain the two highway bridges as part of the Cape Cod Canal Federal Navigation Project is the River and Harbor Act of 30 August 1935, 74th Congress, 1st Session (P.L. 74-409).

1.3 Study Purpose and Scope

The purpose of this report is to present analysis and findings relative to the continued repair and maintenance of the two highway bridges, major rehabilitation of the bridges, or replacement of the bridges with new structures that will provide land access between the Cape and the mainland. The study has been conducted in accordance with the requirements of ER 1130-2-500, including EP 1130-2-500 Project Operations, Appendix B – Rehabilitation Evaluation Report.

> *ER 1130-2-500 (27 Dec 1996) Project Operations – 3.2 Policy – It is the policy of the Corps of Engineers that (a) A Major Rehabilitation Program shall be implemented and maintained for construction of infrequent, costly structural rehabilitation or major replacement works that are intended to improve reliability or efficiency of a Corps project or a principal feature thereof. A conceptual approach to major rehabilitation analysis can be found in "Guidance for Major Rehabilitation Evaluation Reports." Specific criteria for inclusion of projects in the Major Rehabilitation Program and guidance for justification and programming of major rehabilitation projects is provided in Chapter 3 of EP 1130-2-500.*
>
> *EP 1130-2-500 (27 Dec 1996) Project Operations – 3.3 Rehabilitation Categories - Major rehabilitation shall consist of either one or both of two mutually exclusive categories - Reliability or Efficiency Improvement.*
> *(a) Reliability: Rehabilitation includes actions intended to improve reliability of an existing structure with the result of deferring capital expenditures to replace the structure. Rehabilitation is an alternative to replacement when it can significantly extend the physical life of a project feature and can be economically justified by benefit-cost analysis. Rehabilitation does not include routine or deferred maintenance activities.*
> *(b) Efficiency Improvement: Efficiency improvements are actions beyond or separate from rehabilitation that will enhance the operational efficiency of major project components and will increase outputs beyond the original project design.*

This report presents a study of alternatives to address current and potential future deficiencies of components of the bridges which impact their structural and operational reliability. The objective is to identify the alternative(s) which, based on engineering reliability analysis, economic analysis, and environmental studies, will best allow the USACE to meet its obligation to provide for access over the Canal and avoid bridge closures and other impacts to marine, vehicular, and other traffic. The report summarizes the analyses and recommendations. The study's rigorous specific engineering, economic and environmental analyses are detailed in the accompanying Environmental Assessment and in the report appendices.

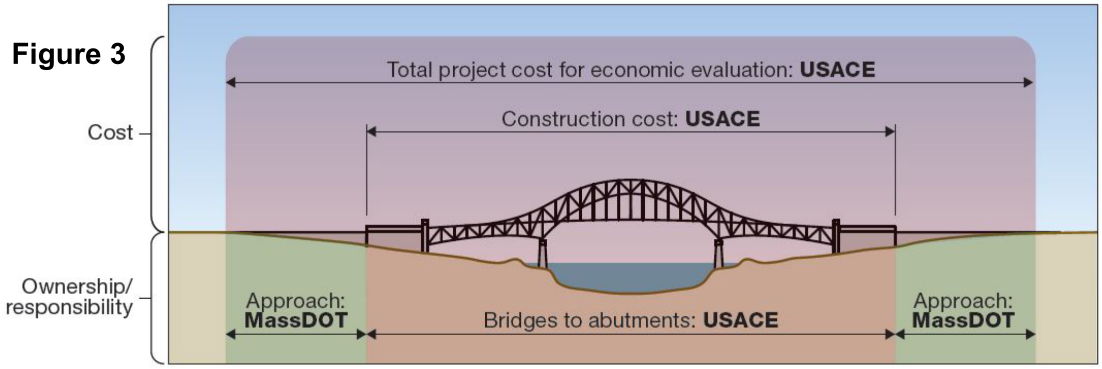
This report presents reviewers, reporting officers, and others with sufficient detailed information to make decisions on implementation of the recommendations, including cost-sharing and partnership opportunities and budgeting. The report determines and presents the base condition of the two highway bridges by defining the current and future ("without–project") condition and performance. Problems with current and future reliability are identified and evaluated from this base condition. Alternatives are then formulated to address and manage these problems and risks. The alternatives are evaluated under a risk-informed tiered screening approach to carry the most likely implementable options forward for detailed analysis. Alternatives design, cost and risk analysis, economic assessment, environmental impact assessment, and other potential impacts are then investigated and detailed evaluations conducted for the most likely alternatives.

1.4 Project Sponsor

There is no non-Federal sponsor for the Cape Cod Canal Federal Navigation Project as a whole or for the two highway bridges. The Canal and its appurtenant features were purchased from a private corporation by the Federal government. The modified deep draft portions of the present Canal, the bridges and appurtenant structures were constructed at full Federal expense without any non-Federal cost-sharing or partnership/cooperation agreements. The three small boat harbors constructed along the Canal route were also initially implemented at full Federal expense. The Commonwealth of Massachusetts has been the non-Federal sponsor for modifications/improvements to those three small boat harbors; Buttermilk Bay channel extension 1983, East Boat Basin anchorage enlargement 1961, and Onset Bay channel and anchorage extension 1957.

Federal ownership of the two existing highway bridges covers the area between the shoreward abutments of both bridges. This is the extent of Federal land ownership in the area of the bridges. Landward of the abutments the Commonwealth (MassDOT) is the land owner and operates and maintains the highway approaches to the bridges. The figure below shows the extent of Federal and State responsibility for the existing bridges.

Figure 3


Cost
Total project cost for economic evaluation: USACE
Construction cost: USACE
Ownership/ responsibility
Approach: MassDOT
Bridges to abutments: USACE
Approach: MassDOT

The USACE has had preliminary discussions with the MassDOT concerning state assumption of ownership of the highway bridges, however any detailed consideration of such proposals awaits the decision on the fate of the existing bridges and any replacement.

1.5 Study Participants and Coordination

The preparation of this report required the cooperation of Federal agencies, state and local government agencies, elected officials of the state and local governments, local commercial interests, and interested individuals. Appendix E contains a record of public involvement, cooperating agencies, coordination, and project correspondence. The Massachusetts Department of Transportation (MassDOT), Highway Division, the U.S. Department of Transportation, Federal Highway Administration (FHWA), and the Towns of Bourne and Sandwich, Massachusetts were key partners in the study. The Environmental Assessment accompanying this document also provides a detailed account of public and agency involvement and coordination for this study.

Strategic Partner Coordination was maintained through an executive leadership team (ELT) comprised of regional senior leaders for the USACE, MassDOT, and FHWA was formed to discuss critical project elements and potential hurdles to work being undertaken by the respective organizations in an effort to streamline processes. ELT meetings occurred generally monthly starting in December 2017 and continued through the finalization of the MRER. Working level meetings between project managers from the USACE MRER and the MassDOT Cape Cod Transportation Study started at the initiation of the MRER in early FY 2016 and have occurred bi-weekly throughout the completion of the MRER. USACE staff participated in numerous meetings regarding the Cape Cod Transportation Study working group public meetings, and the Cape Cod regional metropolitan planning organization (MPO) meetings providing status of the MRER project and early study results (when applicable) to Federal, state, and local agencies, and interested community members. MassDOT staff were in attendance and/or presented information relative to the transportation study at all 10 USACE MRER public meetings. Technical staff from FHWA Eastern Federal Lands Division (EFLD) were also in attendance at all USACE MRER public meetings.

Due to the importance, complexity and scale of the this project, and Cape Cod region projects being contemplated by MassDOT, the USACE New England District and MassDOT entered into a Memorandum of Understanding (MOU), signed on June 28, 2018, to engage in a collaborative approach to cooperatively share information on: respective planning studies, maintenance construction activities, potential funding and financing options, and future project development concerning the bridges, approaches, and adjacent infrastructure to reduce impacts to the traveling public and limit expenditure of scarce public resources. MassDOT reviewed the draft MRER/EA document prior to its release in October 2019. MassDOT provided official comments on the draft document as a result of the coordination process which are included in Appendix E.

FHWA is the Nation's leader in regulation, development, design and execution of large and complex transportation related projects. As such USACE entered into an interagency agreement (IAA) with the EFLD for technical assistance related to the development/review of the MRER. EFLD provided input on guidance to transportation (specifically bridge) projects and played a critical role in reviewing the MRER/EA and all appendices prior to release of the draft documents for public review. The FHWA Massachusetts regional office reviewed the draft MRER/EA and provided comments relating to his authority through the Federal coordination process. FHWA comments are also included in Appendix E.

A similar process of interagency engagement and public coordination will be carried out throughout the next phase of this project. Federal, state, regional and local agencies and officials and the public will be invited to participate in the process and provided an opportunity to review and comment on any planning and NEPA documents produced.

1.6 Environmental Operating Principles

The USACE has reaffirmed its commitment to the environment in a set of "Environmental Operating Principles". These principles foster unity of purpose on environmental issues and reflect a positive tone and direction for dialogue on environmental matters. By implementing these principles within the framework of USACE regulations, the USACE continues its efforts to evaluate the effects of its projects on the environment and to seek better ways of achieving environmentally sustainable solutions in partnership with stakeholders.

The seven “Environmental Operating Principles” are as follows:

1. Foster sustainability as a way of life throughout the organization.
2. Proactively consider environmental consequences of all USACE activities and act accordingly.
3. Create mutually supporting economic and environmentally sustainable solutions.
4. Continue to meet our corporate responsibility and accountability under the law for activities undertaken by the USACE, which may impact human and natural environments.
5. Consider the environment in employing a risk management and systems approach throughout the life cycles of projects and programs.
6. Leverage scientific, economic and social knowledge to understand the environmental context and effects of USACE actions in a collaborative manner.
7. Employ an open, transparent process that respects views of individuals and groups interested in USACE activities.

1.7 USACE Campaign Plan

The USACE Campaign Plan guides policy decisions on how we organize, train, and equip our personnel; how we plan, prioritize, and allocate resources; and how we respond to emerging requirements and challenges and meet national priorities. The Campaign Plan is regularly updated and the current version of the plan covers the period of FY2018 to FY2022.

The USACE strategic plan effort towards improvement began in August 2006 with the “12 Actions for Change” and has evolved to four goals and associated objectives. Although the effort originally developed with a focus on missions that seek to manage risk associated with flooding and storm damage, the Campaign Plan Goals and Objectives are applied to all aspects of the USACE service to the nation including its civil works mission. USACE

Campaign Plan Goals and Objectives are derived, in part, from the Commander's Intent, the Army Campaign Plan, and Office of Management and Budget guidance. The four goals are (1) Support National Security, (2) Deliver Integrated Water Resource Solutions, (3) Reduce Disaster Risk, and (4) Prepare for Tomorrow.

The goal and associated objectives most closely related to the study and recommendation for repair, rehabilitation or replacement of the Cape Cod Canal Highway Bridges is:

Goal 2: Deliver Integrated Water Resource Solutions

Objective 2a – Deliver Quality Water Resources Solutions and Services

The Recommended Plan for improvements to long term landside access across the Cape Cod Canal meets this objective by delivering project features which, within the limits of Federal participation established by Congress, meets to the extent practicable the expectations of our partners and stakeholders in maintaining safe and efficient highway access between the mainland and Cape Cod.

Objective 2c – Develop the Civil Works Program to Meet the Future Needs of the Nation

Analysis of alternatives and recommendation of a practicable solution to long term land access across the Cape Cod Canal meets this objective by delivering a project which, within the limits of Federal participation established by Congress, provides a sustainable system of access improvements and improves resilience through consideration of climate change and risk management in its design. The study and recommendation were conducted with stakeholder engagement and the public has been provided an opportunity to review and comment on the study and its recommendations through the NEPA process.

Objective 2d – Manage the Life-Cycle of Water Resources Infrastructure Systems to Consistently Deliver Reliable and Sustainable Performance

The project has been formulated with the complete life-cycle in mind, with a consideration of the costs and impacts of repair, rehabilitation, and replacement of crossings of the Cape Cod Canal, all including both initial construction and future operations and maintenance, to determine the most cost-effective alternative solution to address problems and opportunities with land access across the Canal between the mainland and Cape Cod.

In addition to Civil Works it must also be recognized that the Cape Cod Canal highway bridges, particularly the Bourne Bridge, provide the only vehicular access from the mainland to Joint Base Cape Cod, home to five military commands of the Massachusetts Army and Air National Guard (Otis ANG Base) and the Federal Government (US Air Force and US Coast Guard), and Tactical Training Base Kelly (MANG and Army Reserve). Maintaining safe and efficient vehicular access to these facilities contributes to Campaign Plan Goal 1 – Support National Security.

2.0 PROBLEMS AND OPPORTUNITIES

The Cape Cod Canal was constructed to provide a shortened route for navigation between the Gulf of Maine and North Atlantic waters to the south. Construction of the 17.5 mile long Canal (land cut plus sea approaches) divided the Towns of Bourne and Sandwich and left most of those two towns and all the other 13 towns in Barnstable County dependent on bridges to access the mainland. The eight municipalities in Dukes County (Nantucket, Marta's Vineyard and the Elizabeth Islands) also depend on the bridges for access as their ferry connections run through the southern harbors on the Cape. The problem lies in identifying the most cost effective means of providing for safe and efficient vehicular traffic between the mainland and the Cape and islands over the long term without impacting projected navigational use of the Canal while minimizing environmental and socio-economic impacts.

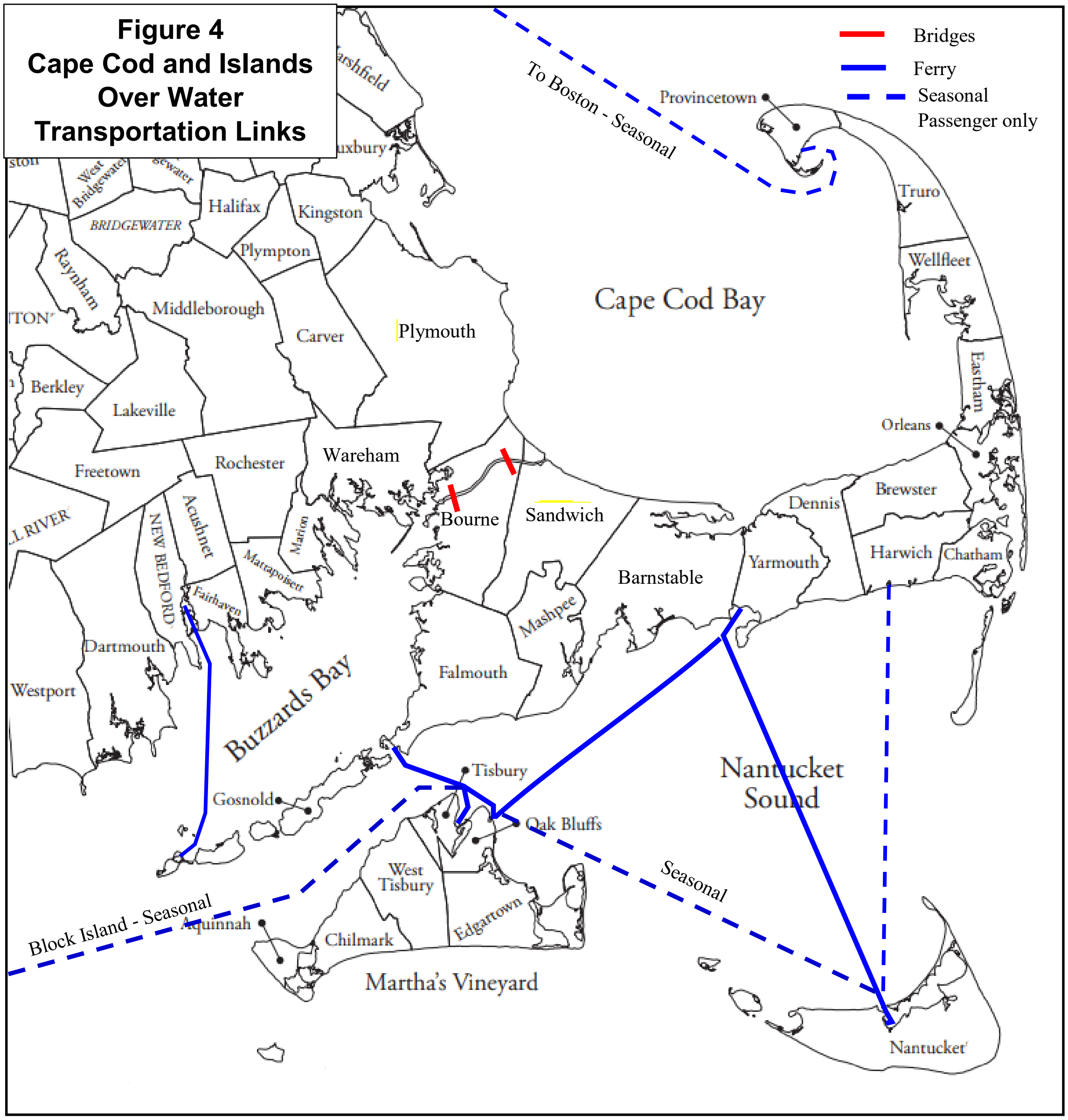


Figure 4
Cape Cod and Islands Over Water Transportation Links

2.1 Project Navigation Use

The Canal remains an important waterway for coastwise traffic. Records of navigation use of the Canal are kept by the USACE-NAE Cape Cod Canal office and by the Army Corps of Engineers Waterborne Commerce Statistics Center (WCSC). The Canal's records cover all vessel types and sizes, while the WCSC data cover only cargo vessels. Both data sets are presented in Table 1 and Table 2 below. In total the Canal sees about 17,000 to 21,000 transits annually of all vessel types (2013-2017 data), of which about 7,500 were ships of more than 65 feet in length. Auto carriers, cruise ships and military vessels are among the largest ships that use the Canal today.

Table 1 – Canal Vessel Traffic – 2013-2017

Vessels Over 65 Feet in Length						
	2013	**2014**	**2015**	**2016**	**2017**	**2018**
Passenger, Dry Cargos	1,025	1,084	1,043	1,063	1,064	1,102
Tankers	55	34	15	39	49	68
Towboats	3,191	3,407	3,242	3,293	3,057	3,225
Dry Cargos, Scows	384	330	294	308	238	265
Tanker Barges	1,302	1,270	1,225	1,249	1,259	1,334
Fishing Vessels	780	756	811	848	877	492
Yachts	684	680	726	665	695	720
Military Vessels	147	202	169	223	156	165
Others	90	83	145	210	88	74
TOTAL	7,658	7,846	7,670	7,898	7,483	7,445
% of Total	43.8%	41.5%	39.0%	40.9%	35.6%	34.1%
Vessels Under 65 Feet in Length (Estimated)						
	2013	**2014**	**2015**	**2016**	**2017**	**2018**
Fishing Vessels	139	225	333	308	344	422
Pleasure Craft	4,205	4,458	5,580	7,304	7,380	7,911
Misc. Vessels	5,483	6,397	6,089	3,804	5,798	5,985
TOTAL	9,827	11,080	12,002	11,416	13,522	14,318
TOTAL all Sizes	17,485	18,926	19,672	19,314	21,005	21,736
Source: USACE-NAE Canal Records						

Table 2 – Canal Cargo Vessel Traffic – WCSC Data - 2012-2017						
	2012	**2013**	**2014**	**2015**	**2016**	**2017**
Foreign Flagged Vessels	2,665	3.432	1,441	286	270	308
Domestic Flagged Vessels	1,243	1,381	1,412	1,332	1,566	1,124
Total Vessels	3,908	4,813	2,853	1,618	1,836	1,432
Source: Waterborne Commerce Statistics Center						

The WCSC also publishes annual statistics showing commodity volumes and commercial cargo vessel trips through major U.S. ports and waterways including the Cape Cod Canal. Those data show an average of 8,043,000 tons of cargo were shipped through the Canal annually between 2012 and 2017, the most recent year for which WCSC data is available. Commodity shipments through the Canal have been dominated primarily by petroleum and petroleum products, which accounted for 79.0% of all freight tonnage over those five years. Chemicals were the next largest category at 11.4%, followed by primary manufactured goods at 7.1%. Together, these top three categories accounted for 97.5% of total freight tonnages over those six years. Cargo volumes through the canal for the past six years are shown in the table below.

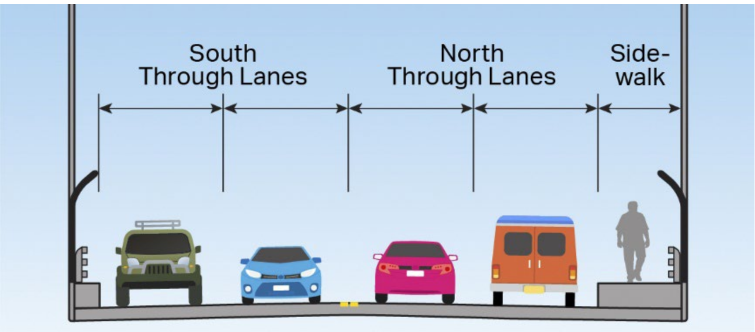
Table 3 – Canal Waterborne Commodities – 2012-2017								
Cargo Carried – Thousands of Short Tons								
Commodity	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**Total**	**%**
Petroleum & Petroleum Products	7,113	8,657	6,484	5,365	5,409	5,097	38,125	79.0
Chemicals	812	743	1,015	1,119	1,126	703	5,518	11.4
Crude Materials	286	55	66	49	15	39	510	1.1
Primary Manufactured Goods	365	394	391	355	246	1678	3,429	7.1
Food & Farm Products	2	13	6	0	0	4	25	0.1
Manufactured Equipment & Machinery	174	141	73	63	36	63	550	1.1
Coal	10	45	0	0	43	0	98	0.2
TOTAL	8,762	10,148	8,035	6,951	6,875	7,584	48,255	100.0
Average (6 Years)							8,043	
Source: Waterborne Commerce Statistics Center								

2.2 Bridge Traffic

During design for new highway crossings of the then soon to be expanded Canal in the early 1930s, estimates of vehicle traffic volumes ranged from average daily low winter numbers of 1,200 to peak summer Sunday numbers of 4,700. These were stated as monthly totals for both bridges as 36,000 vehicles/month in winter and 142,000 vehicles/ month in summer (House Document #795, 71st Congress, 1931).

Today the bridges are used by the 215,000 year-round residents of Barnstable County and the five million visitors to the Cape each year. The existing 85-year old bridges no longer meet current highway safety standards or adequately reflect modern-day traffic conditions. Traffic volumes have increased since the bridges were originally constructed, leading to significant increased loading and demands on bridge infrastructure. Routine maintenance will not be able to keep pace with current traffic and loading demands. Bridge traffic will continue to contend with narrow vehicular lanes, lack of shoulders, lack of separation medians, and narrow sidewalks (see Figure 5).

Figure 5 – Deck Section for Existing Bridges



The existing Sagamore and Bourne Bridges have four 10-foot wide vehicle lanes and one combined pedestrian/bicycle lane.   There are no shoulders or medians. The left-hand lane in each direction doubles as an auxiliary lanes for entering and exiting traffic.

The latest Annual Average Daily Traffic (AADT) was obtained from Massachusetts Department of Transportation's (MassDOT) permanent traffic counting stations nearest the bridges. The most recent 10-year average was chosen for the engineering analysis at both bridges. The 10-year AADT for the Bourne Bridge was 44,447, and for the Sagamore Bridge was 51,756. For 2018 the AADT was 45,853 for the Bourne Bridge and 55,035 for the Sagamore Bridge. This level is about thirty times the volume of traffic projected in the 1930s studies on which the design of the existing bridges was based. Initial numbers for 2019 show an increase over the 2018 volumes. The Economic Appendix (D) provides detailed information on traffic modelling and MassDOT's regional transportation study. Traffic data used in the Economic analysis distinguished between winter and summer months and used the lower winter data to estimate impacts of lane and bridge closures as those activities would not normally occur during summer.

2.3 Problems

From their completion of construction in 1935 both highway bridges have undergone a typical history of operation, maintenance, repair and rehabilitation. Each bridge underwent a major rehabilitation program in the early 1980s, about 45 years after initial construction. Since that last major rehabilitation each bridge has averaged about $1 million annually in maintenance and repair costs, with the Bourne Bridge costing slightly more than the Sagamore Bridge. Both bridges are due for another major rehabilitation effort in the mid-2020s.

As the two bridges continue to age the cost and need for maintenance and repairs is expected to increase. The bridges major system components, the substructure (the piers and abutments and their foundations), the deck (the steel and concrete deck and its paved surface), and steel superstructure (trusses, floor beams, stringers, hangers, etc.) are all expected to require increased attention and work to keep ahead of deterioration. Maintaining reliability and safety of the bridges will require an increased investment over time and may ultimately prove insufficient to avoid limiting vehicle loads on the bridges.

The problem presented is to identify the most cost-effective means for providing long-term safe and reliable vehicular access across the Cape Cod Canal between the mainland and the Cape, and by extension (Cape Cod based ferry services) to the islands of Nantucket and Martha's Vineyard. Besides being arteries of transportation and commerce, the bridges are hurricane evacuation routes and provide access to government (including military) facilities. Reliable safe access across the Canal is critical to the region and its economy.

2.4 Opportunities

The opportunity presented is for the USACE to determine the most cost-effective long-term means of fulfilling its obligation to provide for two safe and reliable vehicle crossings over the Cape Cod Canal while ensuring continued marine traffic through the Canal. This study will examine whether and to what extent this opportunity can be met for each bridge by either a comprehensive program of major rehabilitation and repairs, or by replacement of each bridge with a new vehicle crossing.

A Major Rehabilitation effort would provide the opportunity to correct known deficiencies in each bridge, replace aged components, and to clean and repair other components of the bridge systems. Reliability for each bridge can only be ensured when all bridge components are maintained in a condition that avoids failure. Opportunities may also exist to improve performance of repairs and maintenance while reducing impact. For example, use of more modern paints to cover and protect steel members and prevent accelerated corrosion could also have a lesser impact on the environment than paints used in the past. Coordinating sequential schedules for rehabilitation of both bridges may allow for contract savings while also reducing impacts to vehicular traffic from lane and bridge closures.

The study of providing new vehicle crossings will also present the opportunity to upgrade the crossings to modern highway design standards which should improve safety and reliability. Adequate provisions for non-vehicle crossing of pedestrians and bicycles would also be investigated.

3.0 IDENTIFICATION OF ALTERNATIVES

A Major Rehabilitation Evaluation Report typically focuses first on the condition; i.e. the engineering reliability, of the existing structure with emphasis on the cost to operate, maintain, repair and rehabilitate that structure in a manner consistent with its authorized purpose and public safety. With respect to the Cape Cod Canal and the future of its highway bridges public debate has been underway for several decades, escalating as the bridges continue to age and as maintenance and repairs result in ever more frequent and lengthy impacts on vehicular traffic. This section presents a brief overview of the different alternatives for the future of the Canal and its crossings, the number of crossings, the methods of crossings, and even the continued utility of the Canal itself as a navigation project.

3.1 Alternatives in General

Consideration of land access across the Cape Cod Canal first involves a discussion of the number of access points, and the method of crossing. Whether to have a single high-capacity crossing, or two or more lower-capacity crossings has been discussed since the first state charters for building a canal were issued in the late 1800s. The 1899 state charter and its amendments required the Canal Company to construct and maintain two bridges over the Canal, one near each end of the land cut, to reconnect the mainland and Cape side areas of the two municipalities bisected by the Canal (Bourne and Sandwich). The original low-level bascule leaf draw spans were built to satisfy this state requirement. The reports published in 1931 in House Document #795 recommended to Congress that a single fixed-span high-level highway bridge be built at the center of the land cut to replace the two low-level bridges.

The Public Works Administration ultimately approved and funded the plan for constructing the two existing high-level fixed-span highway bridges at Bourne and Sagamore. In his report of December 26, 1934 to Congress (House Committee on Rivers and Harbors Document #15, 74th Congress, 1st Session, 1935) the Chief of Engineers stated the rationale for this decision as follows *"The obligations imposed on the United States in acquiring the canal prevented the substitution of a single highway bridge for the two present crossings and two fixed highway bridges are therefore being constructed."* Any determination on the merits of one crossing versus two crossings today would require an examination of the relative costs, benefits, and impacts of the alternatives.

The existing state highway system, including state Routes 3, 25, and 28, U.S. Route 6, and the nearby terminus of Interstates 195 and 495 have all been constructed to align with the two existing bridge crossings. Local roadways have also been constructed to connect with the system or avoid the current bridge footprints. Any plan to replace the two existing crossings with a single centrally located crossing would also involve relocation/extension of the landside bridge approaches and connecting roads and highways on both the mainland and Cape sides of the Canal.

The method of crossing the Canal in also a consideration. The decision in the 1930s to replace the low-level draw spans with high-level fixed spans was made at a time when the Canal's 32-foot design depth could accommodate all but the largest commercial ships, and all

U.S. Naval vessels then in service. Today the majority of large commercial carriers, and the largest naval surface combatants cannot navigate the Canal's limited depth and turns. The question of crossing method must be examined in the context of the Canal's continued ability to accommodate deep-draft vessel traffic and appropriate design vessels to consider when examining issues such as bridge clearances. Fleet distribution and transit frequency by vessel size, vessel air draft, use of tidal assistance relative to vessel draft, consideration of sea level change, and other factors will need to be examined with respect to bridge elevations and type.

Alternative crossing measures to high-level bridges include tunnels. Those too must be examined with respect to the future carrying capacity and navigation utility of the Canal. Any crossing solution requiring new structures, whether bridge or tunnel, would likely have a life of up to 100 years. Their design must be examined with respect to the likely future of the Canal. Would any future effort to improve the Canal for deeper vessels (depth, widths and alignment) be justifiable and otherwise feasible during the next century?

The deepening of the Canal for larger vessel drafts would also require major modifications to accommodate the increase in vessel length and beam that come with greater draft. Realignment of the approach channels and straightening the bends in the land cut would likely be required. Widening of the land cut and the eastern entrance between the jetties would also be required. Accommodating these changes would require relocating roads, utilities, recreation areas, power plant intakes/discharge sluiceways, and removing and resetting bank stabilization measures, modifying or relocating fish-ways and marsh tide gates, to name just a few. While changes to the vertical clearance of any new bridges might allow for greater vessel air draft, the constraint then would be the recently rehabilitated railroad bridge, which also has a 135-foot MHW clearance. Such wholesale modifications to the navigation features of the Canal are beyond the scope of this MRER for the Canal's highway bridges. As Congress has not requested a study of potential deep draft improvements to the Canal detailed consideration of a future condition where larger vessels can be accommodate by a deeper and wider canal is not practicable.

Tunnels like other critical utilities located beneath waterways must account in their design elevation for dredging activities and vessel groundings above them. Dredge depths, allowable pay overdepth, non-pay overdepth, advanced maintenance dredging increments, safe clearance and cover needs, and armor layer thickness above the tunnel tubes all are considerations in tunnel design elevations beneath waterways. The type of tunnel and method of construction will also have different requirements for depth beneath the channel.

Public discussion of the future of the Cape Cod Canal Highway Bridges has escalated since the 1980s major rehabilitation actions, as the year-round and seasonal population of the Cape and Islands continues to grow. In the past several years public perception of the bridges performance and safety has waned as lane closures more frequently interrupt traffic on and off the Cape. Public debate and discussions between state and Federal agencies has yielded a wide range of potential futures for the Canal and its crossings. Many of these alternatives were raised during the public information sessions on the bridges study held on the Cape and Islands in early December 2018. A list of these alternatives is provided below, and each will be outlined conceptually. Detailed analysis of the existing condition and the various alternatives will be provided in subsequent sections of the report as alternatives are screened to identify the detailed plans to be carried forward.

Table 4 – List of Alternatives

	Description	**Special Considerations**
Base A	Continued Maintenance and Repairs (Fix as Fails) to Both Existing Bridges as Needed to Maintain Safety. Basis for measuring all other alternatives.	This is the Federal Base Plan – the Without Project Condition
B	A Program of Repairs and Major Rehabilitation for Both Bridges to Maintain Safety and Avoid Future Restrictions on Bridge Weight Postings	Major Rehabilitation of Each Bridge is Required about every 45 Years.
C	Replacement of One or Both Highway Bridges with New Bridges Each Limited to Four Widened Lanes, with Shoulders, Medians, and Sidewalks	Each Old Bridge would Remain in Service until the New Bridge was Completed
D	Replacement of One or Both Highway Bridges with New Bridges as in Plan C, but with Two Auxiliary Lanes Added	Each Old Bridge would Remain in Service until the New Bridge was Completed
E	Replacement of One or Both Highway Bridges with New Bridges with Additional (More than Four) Non-Federally Funded Through Traffic Lanes, plus Two Auxiliary Lanes	Each Old Bridge would Remain in Service until the New Bridge was Completed
F	Replacement of Both Highway Bridges with a Single New Bridge	Both Old Bridges would Remain in Service until the New Bridge was Completed
G	Non-USACE Construction of a New Third Highway Bridge	This is a State Implemented Alternative
H	Replacement of One or Both Highway Bridges with Tunnels	Each Old Bridge would Remain in Service until the New Tunnel was Completed
I	Replacement of Both Bridges with a Single Tunnel	Both Old Bridges would Remain in Service until the New Tunnel was Completed
J	Replacement of One or Both High Level Bridges with Low Level Draw Spans	Each Old Bridge would Remain in Service until the New Bridge was Completed
K	Replacement of Both Bridges with Low Level Crossings on Causeways with Draw Spans for Shallow Draft Navigation	Both Old Bridges would Remain in Service until the New Causeway was Completed
L	Deauthorization and Closure of the Cape Cod Canal, Filling the Land Cut, and Restoration of Surface Highways, Drainage and Estuarine Ecosystems	Includes Retention of the Shallow Draft Harbors at Each End of the Canal (East Boat Basin, Buttermilk Bay and Onset Bay Projects

In order to analyze the alternatives, including major rehab and replacement, they have to be compared to some base condition so that their different costs and benefits can be weighed. A fix-as-fails alternative has been used on other MRERs to fill this purposes. The District's project delivery team (PDT) determined that this same approach would provide a sound basis for decision-making given the nature of this project. The existing bridges are high-use structures. The travelling public requires a level of safety and reliability which must be maintained. Current public law mandates a 24-month inspection cycle for public highway bridges. The "fix-as-fails" alternative is the most likely scenario for a base plan as the USACE cannot abandon the bridges or leave them in-place with no ongoing inspection or operations and maintenance actions.

3.2 Federal Base Condition – Without Project Condition – Continued Maintenance and Repairs to Both Existing Bridges – Alternative A

Under the Base Plan the USACE would continue to repair and maintain the two highway bridges as needed to maintain safety. Major rehabilitation efforts would not be conducted and components of the structures would be repaired and critical elements replaced as they deteriorate and before they fail. Under this option, without major rehabilitation, each bridge would ultimately reach a point where routine maintenance and minor component replacement would no longer yield acceptable design performance. At such a point the bridges would need to be posted to limit the loaded weight of heavy vehicles in order to assure continued bridge safety. Lower vehicle load and speed limits would be posted in the future as the bridges continue to age.

Over time this alternative would have escalating impacts on vehicle traffic and the economy of the Cape and Islands as large trucks transporting critical goods and services were replaced by ever smaller trucks. The cost of transporting goods onto and off the Cape would rise over time. More trucks and lesser speeds would result in more frequent and lengthier traffic delays. Vehicle emissions would increase and tourism would be discouraged by these conditions.

3.3 A Program of Repairs and Major Rehabilitation for Both Bridges – Alternative B

To maintain bridge safety and performance, and to avoid the need for future restrictions through vehicle weight postings and other safety measures, the bridges would each need to undergo a major rehabilitation cycle within the next six years, and at least every 45 years thereafter. The ongoing program of continual inspection, maintenance and repairs would also continue throughout the remaining life of the bridges. Major rehabilitation involves extensive repairs and replacement of major bridge components such as the connections between the spans and the piers/abutments, the hangers that help connect the deck and the truss sections, the gusset plates that tie the truss members together, and the substructure members of the decks themselves. Each of these are major actions that would require partial or full closure of the bridges to traffic during the work.

Major rehabilitation programs were undertaken for both highway bridges in the early 1980s, and involved extensive repair and replacement of major bridge components such as cables, plates, and decking. These actions required partial closures of each bridge for extensive periods resulting in traffic congestion and delays.

3.4 Replacement of One or Both Highway Bridges with New Bridges – Alternatives C, D and E

Should it prove a more fiscally sound option, and better meet the need for public safety and reliability, one or both bridges could be replaced with new high-level highway bridges under a plan that retains the current two-crossing system. In order to minimize impacts on connecting roads and other non-Federal highway and local roadway modifications, each bridge would be replaced along approximately the same alignment as the existing bridges, parallel to them and offset by the width of the new bridge and the needs for construction access. This would minimize the real estate takings needed for the new bridges and connecting road modifications. The actual location, type, and design of any new bridge(s) would be evaluated and determined by further design studies (Phase II).

A new bridge would need to account for changes in highway and bridge engineering design standards since the original bridges were designed in the early 1930s. For example standard safe travel lane widths today are generally 12 feet compared to the 10 feet on the existing bridge decks. Pedestrian and bicycle lanes require a separation barrier from the vehicle lanes. A median should exist between the two directions of vehicular travel. Shoulders to accommodate breakdowns would be needed, and entrance and exit (auxiliary) lanes may be required on the bridge decks due to the proximity of access and exit from the connecting surface roads.

Any new high-level bridge must also take into account the requirements for navigation of the Canal beneath the bridges. Currently the 1930s bridges have a vertical clearance of 135 feet above mean high water (MHW), the same as that of many bridges of their era still in operation today in the northeast, including the Tobin Bridge over the Mystic River in Boston Harbor. The largest ships using the Canal today are auto carriers and cruise ships, many of which have designs that take this 135-foot clearance into account. However sea level has risen slightly since the 1930s and is projected to rise at an accelerated rate due to climate change. Projections of sea level rise would require several additional feet be added to the vertical clearance if the 135 feet were to remain as a goal for navigable transit of the Canal for these vessels. New bridge vertical clearances would need to be based on the current tidal epoch, account for updated tidal elevations, and account for anticipated sea level change during the bridge's design life.

Horizontal clearance for navigation must also be considered. The existing bridges have piers located within the Canal cut, seaward of the slope protection but outside of the channel limits. The channel has a bottom cut width of 480 feet within the land cut reaches, including between the bridges. Locating any new piers on land outside of the Canal cut would require moving the pier locations landward by about 50 feet on each shore. This would open up horizontal clearance, improve navigational safety, and make access to the piers for inspection and maintenance easier. It would also require lengthening of the spans over the waterway which would extend the distance out to the tie-ins to the connecting roads by at least the distance the piers are moved.

Replacement bridges would need to conform to other aspects of modern highway design and safety standards. Currently the bridges transition to connecting surface roads abruptly, since the surface roads are aligned very close to the Canal. The existing outer lanes of both bridges in both directions must double as acceleration/deceleration lanes to facilitate entering and exiting the bridge onto adjoining roadways. At the Cape side of the Bourne Bridge where the bridge ties into the rotary a similar situation occurs with Cape-bound local traffic entering and exiting the rotary, and cross-traffic mixing with bridge-bound and bridge-exiting traffic. Including acceleration/deceleration lanes on the bridge deck would allow for two through lanes of traffic in each direction while improving safety for exiting and merging vehicles, and avoiding the back-up of exiting vehicles onto the through travel portions of the bridge deck.

The State has indicated that it might be willing to fund the cost of additional through-travel lanes on one or both bridges. The current Federal authorization is for the maintenance of bridges with two through-travel lanes in each direction. Either any costs associated with the study, design and construction of bridges and connecting spans with additional through-travel lanes would need to be borne by the State, or new legislation would be required.

These considerations lead to three different scenarios for bridge replacement with each of the two bridges: (1) replacement in-kind with only four lanes on each bridge deck, two for each direction of travel, (2) replacement that retains the original four through traffic lanes (two in each direction) with two additional lanes for acceleration/deceleration, or (3) a non-Federal alternative to add additional through-traffic lanes in one or both directions.

3.5 Replacement of Both Highway Bridges with a Single New Bridge – Alternative F

The preliminary examination and survey report prepared by the USACE in response to the River and Harbor Act of 3 July 1930 and printed in House Document #795, 71st Congress, 3d Session, 3 March 1931, included a recommendation for a single high level fixed span highway bridge in the Bournedale vicinity to replace the two original draw spans. Before any such project could be implemented by the USACE, the Public Works Administration funded the design and construction of two bridges beginning in 1933. After construction was underway House Committee on Rivers and Harbors Document #15, 74th Congress, 1st Session, 1935, published the conclusion that the obligations imposed on the original private canal owner through its state charter required that two highway bridges be provided and maintained by the Federal government. It is possible that decision could be revisited by Congress in favor of constructing a single new crossing as originally intended.

Single crossing proposals have been debated for several decades with various locations more centrally located along the Canal's land cut being considered. Any new single crossing would require an extensive redesign of the local surface roads and regional highway connections on both the Cape and mainland sides of the Canal (see Figure 6). On the Cape side state routes 28, 6 and 6A, and other local surface roads would require major realignments to route around or connect to a new single crossing. This would likely entail extensive real estate takings, including lands from the Massachusetts Military Reservation, as well as wetlands alterations, rerouting of local roadways and utility corridors, and other impacts. On the mainland side state Routes 3 and 25 from the east and west, respectively, would need to be realigned and extended to connect to a new single crossing. Changes in bridge approach grades and elevation for navigation clearance would compound those challenges.

The Commonwealth also briefly considered construction of a new third highway bridge adjacent to the existing Sagamore Bridge, with the premise that each bridge would then only carry traffic in one direction. That proposal would require a reconfiguration of adjacent and connecting surface roads to match the tandem-bridges. This plan would also have little impact on the need to continue with repairs and ultimately rehabilitation or replacement of the existing Sagamore Bridge as that structure continued to age. Though the decreased traffic load on the existing bridge might allow for some deferral of future repair frequency, the new bridge would carry half the traffic volume at Sagamore.

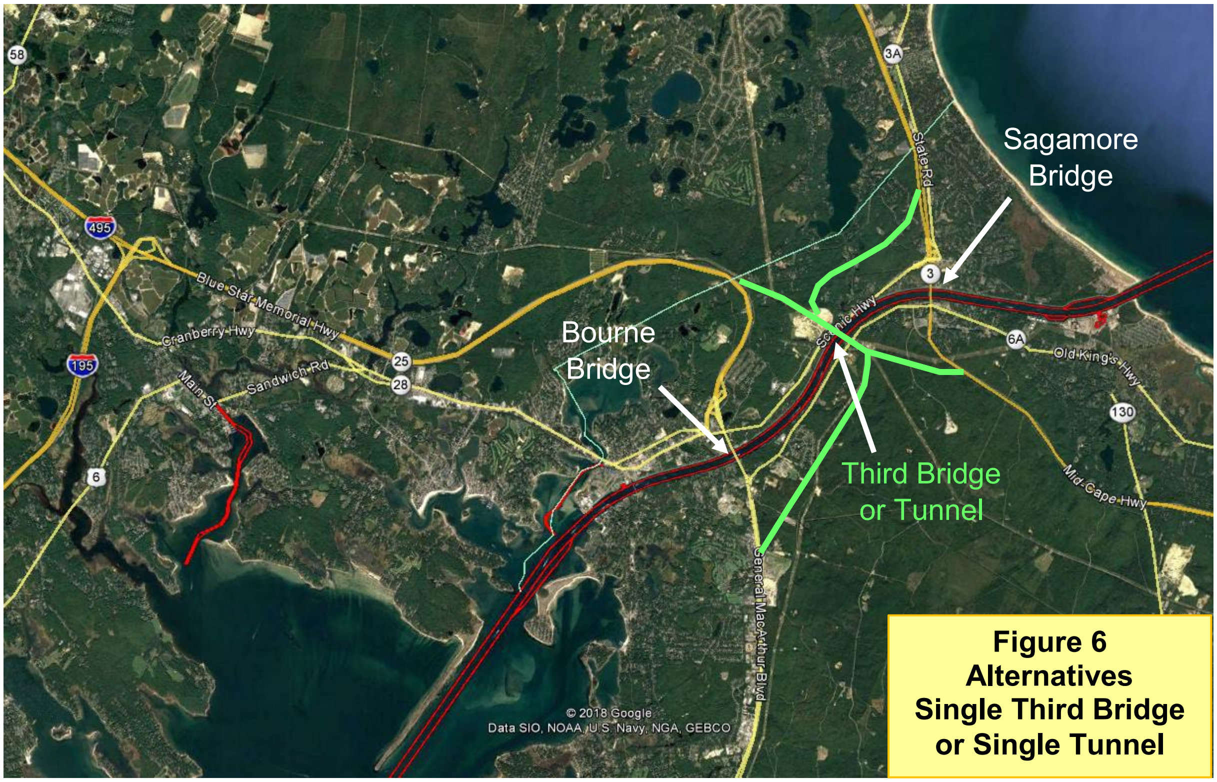


Figure 6
Alternatives
Single Third Bridge
or Single Tunnel

3.6 Construction of a New Third Highway Bridge by Others – Alternative G

The USACE has no current authority to construct a third highway bridge over the Cape Cod Canal in addition to rehabilitation or replacement of one or both of the two existing highway bridges. The Commonwealth has however considered the possibility of constructing a third bridge on its own or in partnership with private interests. While construction of a third bridge is not a part of this USACE Major Rehabilitation Evaluation Study the State's past consideration, and public comment on the possibility, require it's mention since any third bridge would reduce demand and load on the two existing bridges or any replacement of them, and would require modifications to existing approaches and connecting roads. Construction of a third bridge would not alleviate the need to repair, rehabilitate or even replace the two existing bridges as those would remain in service, and so this alternative does not address the need for Federal action.

3.7 Replacement of One or Both Highway Bridges with Tunnels – Alternative H

There have been discussions at the local level, and in the press, for several decades on replacing or augmenting the existing bridges with a tunnel or tunnels. The principal issue with tunnels is cost as driven by the tunnel design parameters. The ability of existing natural foundation conditions to support a tunnel, and what engineered foundation features might be required would need to be investigated. The number of traffic lanes to be carried by any tunnels, and the appropriate tunnel top elevation with respect to the dredged navigation channel above would need to be determined. Given the tunnel depth, grade and surrounding topography, the location where the tunnel(s) portals would daylight and how they would connect with surface roads would also need to be evaluated.

Replacing either bridge with a tunnel would require the tunnel to carry at least as many lanes as a replacement bridge would carry, or four lanes per bridge. Pedestrian and bicycle traffic is generally not permitted in tunnels of any length due to issues with air quality. Auxiliary lanes to ease acceleration for entrance and deceleration for exit could be included in the tunnel design either within the tube or as part of the portals. The existing bridges would remain in service until a tunnel(s) were completed and opened for use.

The method of tunnel construction will have impacts. Use of a tunnel boring machine would enable a deeper tunnel to be built that would not interfere with the dredging of the Canal or any future deepening of the waterway. However due to its greater depth a bored tunnel would likely be longer and have its portals farther from the Canal, requiring more extensive connecting road relocation.

Placing an immersed tube tunnel in sections beneath the Canal in the manner that the Ted Williams I-90 tunnel was built beneath Boston Harbor would have different impacts. An immersed tube would have a higher profile than a bored tunnel and could restrict future use and modification of the Canal depth and width. Dredging a trench across the Canal cut, positioning, sinking and connecting the tube sections, armoring and backfilling activities would all restrict use of the Canal during tunnel construction whereas the tunnel boring method would not.

A key aspect to designing any Cape Cod Canal tunnel would involve consideration of the Canal's future as a deep draft waterway. The present authorized and maintained depth of the Canal's main channel is -32 feet at mean lower low water (MLLW). Maintenance dredging of channels at that depth typically includes a two-foot allowable pay overdepth (to -34 feet MLLW) to account for dredging tolerance and variation between tidal extremes. Below the dredge pay template a safety clearance is typically provided for tunnels and utilities to account for a degree of non-pay overdepth dredging and the remote potential for vessel groundings on the channel bottom above the tunnel. Tunnel designs for immersed tubes also typically include several feet of rock or concrete mattress cover atop the tunnel tube sections. So with an immersed tube design a 32-foot channel with a two-foot overdepth, six feet of safe clearance, and five feet of rock cover, would have a top elevation no shallower than -45 feet MLLW, or 13 feet below the authorized channel depth.

If at some point during the life of the tunnels it was determined justifiable to deepen the navigation channel depth in the Canal, including any widening or realignment of the channel cut, then any tunnels could pose a constraint if not a prohibiting factor to improving the Canal as a commercial waterway. Mitigating this potential impact on the waterway's future would require incorporating a further increment of depth into the tunnel design. This would increase the cost of any tunnel(s) as a greater tunnel depth would require longer tunnels and potentially greater modifications of surface roads to connect with the tunnel(s).

3.8 Replacement of Both Bridges with a Single Tunnel – Alternative I

Replacement of both highway bridges with a single tunnel would combine the challenges of replacing the two-crossing system with a single crossing, and those of building a tunnel beneath the Canal instead of bridges. A single tunnel would need to meet the traffic demands of the two existing crossings, including carrying at least four lanes in each direction. This would likely require more than one tunnel tube. As with the single bridge alternative a single tunnel would be located mid-Canal to best connect with the highway system that now connect to the two bridges (see Figure 3 above). Pedestrian and bicycle traffic would need to be accommodated by alternative means.

3.9 Replacement of One or Both Bridges with Low Level Draw Spans – Alternative J

During the initial public information sessions for this study in December 2018 members of the public suggested that present-day use of the Canal for navigation might allow for a return to the low-level bridge crossings that pre-dated the 1930's high-level bridge designs. Alternatives mentioned for such crossings included draw spans, or low level fixed spans that would only allow for small craft traffic that could pass beneath the bridge(s) at limited tidal stages. Crossings of both these types would eliminate the Canal as a deep draft commercial waterway. Most if not all cargo and military vessels would be required to return to the ocean route around the Cape, Islands and shoals and banks when transiting between northern New England and ports to the west and south. The remaining small craft traffic would be required to wait for bridge openings to transit the Canal. Given the volume of small craft traffic using the Canal this would require the construction or expansion of mooring and anchorage areas in the vicinity of the bridges where vessels could queue-up for openings. Bridge openings could also be expected to impact vehicular traffic, and likely to a more frequent extent than bridge maintenance activities do today.

3.10 Replacement of Both Bridges with Low Level Causeways – Alternative K

Public comment in the initial information meetings also included suggestions that new crossings could be constructed by replacing the bridges with causeways. This differs from Plans J in that there would be no bridges, and from Plan L in that the Canal would not be filled-in. Tidal flow in the Canal would be preserved by including large culverts that would permit tidal exchange, effectively converting the Canal to an estuary. Alternatively the low level fixed bridge openings that would permit limited navigation access for small craft at certain stages of the tide could be used instead of large box culverts. Such measures would eliminate the Canal as a navigable waterway for all but the smallest recreational craft. All commercial and military vessels and larger recreational, fishing and other craft would be required to return to the ocean routes around the Cape, Islands, and shoals and banks when transiting between northern New England and ports to the west and south.

3.11 Deauthorization and Closure of the Cape Cod Canal – Alternative L

Attendees at the December 2018 public meetings also suggested that in view of the vehicular traffic issues, and what is viewed as limited deep-draft navigation utility, that the Canal has outlived its purpose and can be deauthorized and abandoned. These commenters believe that filling the Canal land cut and restoration of the surface highways, natural drainage and estuarine ecosystems would be appropriate and would result in a major savings in public funds in the long term. This would eliminate the Canal as a navigable waterway entirely. All navigation between northern New England and ports to the west and south would be required to return to the ocean route around the Cape and Islands, and the shoals and banks to the east of Nantucket. While this route is more hazardous for all vessels it is particularly dangerous for small craft, so that eliminating the Canal as a waterway would have extensive life and safety issues. Deauthorizing the Canal project would also end Federal involvement in operations and maintenance of the roadways, water courses, and recreational features that are now part of that FNP.

3.12 Screening of Initial Alternatives

The several initial alternatives were screened to determine which would be carried forward for detailed analysis. Screening addressed a number of factors as listed below consistent with the objectives of an MRER to evaluate major rehabilitation and reasonable alternatives which, based on engineering reliability analysis, economic analysis, and environmental studies, will best allow the USACE to meet its obligation to provide for access over the Canal and avoid impacts to marine, vehicular, and other traffic over the 50-year period of analysis.

- Functionality – Does the alternative serve the needs for the public and other users in providing safe, reliable, long-term vehicular access connecting Cape Cod with the mainland?
- Cost – Is the alternative implementable at a reasonable cost, measured over the 50-year period of analysis?

- Impacts – Can the alternative be implemented without significant environmental, social and cultural resource impacts?
- Maintaining Navigability – Does the alternative allow for continued maritime use of the Canal as a safe passage for deep-draft and shallow-draft vessels consistent with Congressional purpose and authorization for the Cape Cod Canal FNP?
- Authority – Is the alternative implementable within the existing Federal authority for the Cape Cod Canal FNP, or would new Congressional authority be needed?

3.12.1 Alternative A – The Federal Base Plan (Fix as Fails) is the No-Action Plan, otherwise known as the Without Project Condition. The USACE would continue operation and maintenance of each bridge, and would make any repairs needed to maintain public safety as the need arose. No major rehabilitation would be carried out under this plan. As the bridges continued to age and repairs begin to no longer entirely address the efficiency, safety, and effectiveness of each bridge, some restrictions on traffic volumes and weight limits would likely be required. As NEPA requires consideration of a No Action Plan this plan will be carried forward into detailed analysis as the base condition against which all other alternatives would be compared and evaluated.

3.12.2 Alternative B – This plan would continue USACE operation and maintenance and repairs for each highway bridge as in Alternative A, plus a program of Major Rehabilitation for each bridge. The USACE has current authority to continue its operation, maintenance, repair, and rehabilitation of the FNP including the highway bridges. Since major rehabilitation of each bridge is needed about every 40 to 45 years, a major rehabilitation action would occur twice within the 50-year project economic period of evaluation for each bridge. Major Rehabilitation would be carried out to the extent needed to delay bridge replacement for as long as practicable. Each instance of repair or rehabilitation could be expected to be more costly, and perhaps more frequent, than before as the bridges continue to age and deteriorate. This plan will be carried forward into detailed analysis.

3.12.3 Alternative C – This plan would involve replacement of one or both existing highway bridges in kind. The USACE has the authority to replace features of the FNP as necessary to serve authorized project purposes including the existing highway bridges. New bridges would have the same number of lanes (4) for vehicular traffic and the same provisions for pedestrian and bicycle traffic. Each old bridge would remain in service until the new bridge was placed in service. For the purpose of this Phase I concept level of the analysis it is assumed that the new bridges would be located adjacent to and inshore of the existing bridges, as shown in Figure 7. This location would minimize changes needed for the adjacent and connecting surface roads. The new bridges would be designed and built to modern highway and bridge standards. Traffic lanes are assumed to be 12 feet wide. The new bridge grades are expected not to exceed four percent, compared to the existing maximum of six percent for both bridges. Entrance and exit ramps to connecting roads would have eased turn radii. There would be a median barrier for traffic separation and breakdown lanes each direction. Vertical clearances for navigation would be a minimum of 135 feet above mean high water (the clearance provided by the existing railroad bridge), with adjustment for historic and estimated future rates of sea level rise. The new channel piers would be located onshore.

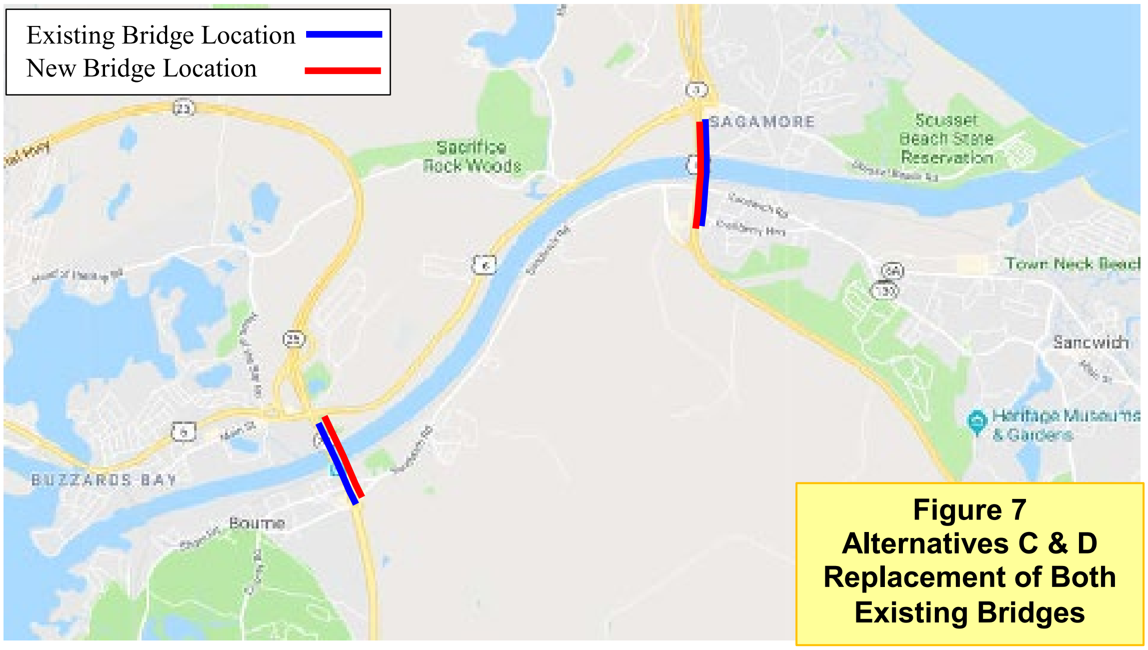


Figure 7
Alternatives C & D
Replacement of Both
Existing Bridges

The two existing bridges with their four through traffic lanes were designed and built in the 1930s to serve far lower traffic volumes than those served by the bridges today. Modern highway design guidance, including AASHTO highway and bridge design specifications and MassDOT design guidance require that entrance and exit ramps include auxiliary lanes for entering and exiting traffic to transition into or out of through traffic safely. Today's higher traffic volumes and vehicle speeds require greater distances for traffic to transition. Distance between the on and off ramps, grades, and ramp turn diameters are all typical factors.

The FHWA stated the following in their comment letter:

> *Based on the close proximity of the interchanges and intersections at the end of each bridge, current standards for this type of facility include acceleration and deceleration lanes (also known as auxiliary lanes) going onto the bridges in most, if not all, four ends of the bridges. In final design, analysis will need to be done to determine if the auxiliary lanes should be continuous across each bridge for operational weaving and structural efficiency needs pending on the structure type, long span bridges such as these may gain cost efficiency with a uniform width.*

MassDOT states the following with respect to the need for auxiliary lanes:

> *The design requirements used for the roadways, intersections, and interchanges shall be in accordance with and the 2006 MassDOT Project Development and Design Guide as well as 2018 American Association of State Highway and Transportation Officials (AASHTO) Policy on Geometric Design of Highway and Streets ("the Green Book"). See Chapter 10 of The Green Book which includes Tables 10-4 Minimum Acceleration Lane Lengths for Entrance Terminals…, Table 10-5 Speed Change Lane adjustment factors as a function of grade…, and Table 10-6 Minimum deceleration lane lengths for exit terminals…; these dictate the required lengths for this type of facility include acceleration and deceleration lanes (also known as auxiliary lanes).*

Providing a replacement for the existing spans in-kind with respect to the number of through traffic lanes would not conform to current design guidance for bridges and highways. For this reason, providing new bridges without auxiliary lanes would not be consistent with best practices for traffic safety, and Plan C will not be carried forward into detailed analysis.

3.12.4 Alternative D – This plan would involve replacement of one or both existing highway bridges, but with four though traffic lanes plus an additional lane added to the bridge deck in each direction for acceleration and deceleration to connect with local roads. The USACE has the authority to replace features of the FNP as necessary to serve authorized project purposes including the existing highway bridges, and that authority extends to designing new bridges to meet modern highway and bridge safety and efficiency standards. Presently the right-hand travel lane in each direction doubles as the acceleration/deceleration lane which limits unrestricted through traffic flow to one lane in each direction. Adding dedicated auxiliary lanes to the bridge decks for acceleration/ deceleration should further ease both through and entering/exiting traffic. All other aspects of this plan would be the same as for Plan C above. As the bridge spans proximity to the connecting roads impacts through traffic flow and traffic safety, designing new bridges consistent with modern highway and bridge safety standards will require adding the dedicated acceleration/deceleration lanes to the bridge decks. Each existing bridge would remain in service until the new bridges were completed and opened to traffic. Final determination of additional deck elevation for sea level rise and navigation clearance, and resulting roadway grades and approach span lengths would all be investigated further and determined during the detailed design phase. This plan will be carried forward into detailed analysis.

3.12.5 Alternative E – This plan would replace one or both existing highway bridges with new bridges that would include additional through traffic lanes in addition to the four traffic lanes and two acceleration/deceleration lanes provided in Plan D. Each existing bridge would remain in service until the new bridges were completed and opened to traffic. Bringing the new bridge designs up to modern standards by increasing traffic lanes widths and adding shoulders and acceleration/deceleration lanes is within USACE existing authority for operation, maintenance, repair and replacement of the FNP features. Adding additional traffic capacity by increasing the number of through traffic lanes is not. Non-Federal interests would need to request such betterments and agree to fully fund the additional costs for design, construction and future operation, maintenance, repair and rehabilitation of those added capacity. The existing Federal authority for the bridges does not include increasing capacity by construction of additional through traffic lanes.

There has been no request from any non-Federal partner to include additional lanes or commitment to fund the additional costs associated with such a proposal. Coordination with MassDOT indicates that the state is not interested in funding addition of through traffic lanes to either bridge at this time. This plan will therefore not be carried forward to detailed analysis. If during the next project phase the state decides that they would be willing to fully fund additional through traffic lanes then any additional studies or design efforts needed to evaluate or support that addition will also need to be funded by the state.

3.12.6 Alternative F –While a single bridge was the original USACE plan for modernizing the Canal in 1930, the decision by Congress in 1934 that the project needed to include two bridges, as further authorized in the 1935 R&H Act, remains the current authorization. The existing surface road system and the regional highways accessing the Cape have all been designed and built to connect with the two existing bridges. Replacement of those bridges with a single bridge at a central location along the Canal would require extensive relocation of existing highways, local roads, and utilities. Highway relocation would have a number of impacts. New lands would need to be acquired by the Federal and State governments for the bridges and connecting roads. Portions of the Massachusetts Military Reservation, significant wetlands areas including those used for agriculture (cranberry bogs), recreational facilities, and existing residential and commercial developments would all be impacted and or displaced.

Overall, construction of a single, centrally located, highway bridge of eight lanes or more to replace the two 4-lane highway bridges at Bourne and Sagamore, would be far more expensive than constructing two smaller bridges at the existing crossing locations. This is principally due to the cost and impacts of relocating state highways, local roadways, and utilities to connect with the new crossing. The existing bridges are more than 3-1/4 miles apart and connect to major highways from different directions on the mainland and on different sides of the Cape. More than 13 miles of new highway would be required to connect the existing highways systems to a new single bridge. Largely through lands already developed for other purposes or set aside as protected resources.

Having two bridges also introduces an important level of redundancy given the need for evacuation routes, access to national defense facilities, and emergency response. If a single bridge were fully or partly closed for repairs or otherwise unavailable there would be no other options for vehicle or pedestrian access across the Canal, and there would be no means of evacuation. Proposals for constructing a new single bridge to replace the two existing bridges will not be carried forward into detailed analysis.

3.12.7 Alternative G –The State's consideration of a third bridge either adjacent to the existing Sagamore Bridge or located elsewhere along the Canal would not relieve the USACE from its need to operate, maintain, repair, rehabilitate or replace each of the two existing bridges as features of the FNP, as required by the R&H Act of 1935. The State and Federal government could agree that any new State bridge would fully replace one or both of the USACE bridges so that the USACE was no longer required to provide vehicular crossings of the Canal and could close and remove either or both the two existing bridges. Or a third bridge located next to an existing bridge could be operated in concert so that each bridge would only carry one direction of traffic, minimizing the need for connecting road alterations. However the State has deferred further consideration of such plans for a new third bridge on its own, and such a plan and agreement would require legislative action by Congress. Proposals by other interests to build a new third highway bridge to supplement the existing bridges are beyond the existing USACE authority. Plan E as discussed above addresses the potential for the State to fully fund additional through traffic lanes on replacement bridges constructed by the Federal government or seek expanded Federal authority to participate in such improvements. Due to the lack of authority and the lack of non-Federal initiative this alternative was not carried forward for detailed analysis.

3.12.8 Alternative H – Proposals to replace one or both of the existing highway bridges with one or more tunnels beneath the Canal will not be carried forward for detailed analysis. Building individual tunnels to replace each bridge carries greater costs than new bridges at each site. Immersed tube tunnels will impact the ability to safely deepen the Canal in the future, and require closure of the Canal for extended periods during construction. If an immersed tube (the least expensive tunnel design to construct) was used, with an assumed change in tunnel bottom elevation of about 100 feet from beneath the Canal to either portal, with a 4 percent roadway grade shoreward of the Canal cut, then at the Bourne crossing the tunnel would be about 5,800 feet long (800 feet under the Canal and 2,500 feet under the either shore). Costs for recent tunnel projects in Norfolk, Virginia were used to develop conceptual costs for tunnels beneath the Canal (see Appendix C – Cost Engineering). An estimated cost for a single 4-lane tunnel with this length would be about $1.2 billion, more than twice the likely cost of a replacement bridge at the same location. Bored tunnels with their greater depth will be even longer and more expensive than the immersed tube design. Significant real estate would need to be acquired for the route of the tunnels and their portals. With an immersed tube design portions of the Canal would need to be closed to navigation during placement of the tube sections. Due to the significant costs and real estate requirements this alternative was not carried forward for detailed analysis.

3.12.9 Alternative I – Replacing both existing highway bridges with a single tunnel beneath the Canal will not be carried forward for detailed analysis. In addition to the reasons discussed in Plan H above for building individual tunnels at each bridge site, building a single tunnel entails other considerations. Building a single tunnel to replace both bridges carries the same impacts and inefficiencies as building a single replacement bridge, but at an even higher cost to construct and maintain. Extensive state and local highways and roads would need to be relocated. Extensive real estate acquisition and relocation would be required to accomplish this. Existing agricultural land, recreation areas, residential and light commercial properties, portions of JBCC, wetlands and other natural areas would also be impacted. Due to these impacts and high costs tunnels, either as a single crossing or individual crossings at the present sites, were not considered further.

Whether or not replacement of the existing bridges with one or more tunnels is within the USACE existing authority is unknown, but most likely additional legislation would be required. The original State charter to the Canal Company gave that company the option to use bridges, ferries or tunnels to provide crossings for the canal. The company elected to build drawspan bridges and operate a small ferry in between to restore the connections between the towns and villages in the Canal's vicinity. During and after the Federal acquisition of the canal navigation improvements that would require new crossings were studied and authorized, but focused on building new bridges and retaining some ferry service for pedestrian traffic. Tunnels were not discussed in those studies. The deed conveying the Canal to the government includes references to the bridges, but not the state charter. By 1933-1935 funds for building two bridges had been provided through the Public Works, National Industrial Recovery, and Emergency Relief Appropriations Acts, and their construction was completed in 1935. Both the Permanent Appropriations Repeal Act of 1934 and the River and Harbor Act of 1935 authorize USACE maintenance of the Canal. The 1935 R&H Act cites House Committee on Rivers and Harbors Document #15 (1934) which includes "maintenance of the new bridges now under construction" in its recommendation. Tunnels were not mentioned then or since in any authorizing document or appropriation.

If tunnels had been shown to likely be a less expensive alternative than replacement bridges for providing and maintaining crossing of the Canal then a more in-depth examination of the breadth of the existing authorization or need for new authority would be in order. However with rough concept-level estimates for tunnels at more than twice the cost of bridges the question of legislative authority for tunnels does not warrant further discussion or explanation. Plans involving construction of one or more tunnels to replace either or both bridges will not be carried forward for detailed analysis.

3.12.10 Alternative J – Constructing new low-level draw spans to replace one or both of the existing high-level fixed spans will not be carried forward for detailed analysis. Congress authorized the purchase and improvement of the Cape Cod Canal to ensure that the Nation had the advantage of its benefits to maritime commerce and later also recreation. Low level draw spans (either bascule or vertical lift spans) in place of high level fixed bridges would place restrictions on marine transit of the Canal, particularly for larger commercial and military vessels. Ships would need to wait for bridge openings, and dredged areas would need to be provided for their queue. Vehicular traffic would back-up significantly while awaiting the passage of marine traffic and closure of the bridges. Draw spans will also require closure to either marine or roadway traffic for maintenance and repairs to the lift leafs or spans. These are all issues that the high level fixed spans were intended to avoid, and will avoid with proper rehabilitation or replacement. Due to the high cost to both land and marine transportation this alternative was not carried forward.

3.12.11 Alternative K – Constructing new low-level causeways, with or without new low-level fixed span bridges to replace one or both of the existing high-level fixed spans will not be carried forward for detailed analysis. As with Plan J above, Congress authorized the purchase and improvement of the Cape Cod Canal to ensure that the Nation had the advantage of its benefits to maritime commerce and later also recreation. Should the Canal's navigable width be restricted by causeways only the smallest craft would still be able to transit the waterway, if it remained open to navigation at all. Due to the high cost to land and marine transportation this alternative was not carried forward.

3.12.12 Alternative L – Deauthorization and filling-in the Cape Cod Canal land cut, and restoring surface highways and roads, restoring natural drainage and estuarine and coastal ecosystems, will not be carried forward for detailed analysis. All vessel traffic between northern New England and the rest of the U.S. eastern seaboard which now uses the Canal would then need to use the more hazardous open ocean routes around the Cape, shoals and banks of the North Atlantic. Longer sea routes would mean great cost of transporting cargo. Even if the three small boat harbors built along the Canal could be retained as part of such a plan, this would represent the loss of an important regional commercial and recreational navigation resource.

From the Federal government's purchase of the Canal to the completion of the 32-foot improvement project in 1941 about 40.5 million cubic yards of material were excavated and dredged from the Canal land cut and sea approaches. While records do not indicate how much of that total volume was from the land cut, if only half of that amount were required to fill the land cut back in the cost would be substantial. While some of the material removed to dredge the Canal was used as fill on the adjacent wetlands and areas that have now been developed for commercial and residential uses, most of those materials were placed in open water disposal sites in Cape Cod and Buzzards Bay. So restoration of wetlands would only provide a portion of the material need to fill the Canal. Acquiring the remaining material would require purchase from upland sources or offshore borrow. The material would need to be transported, placed and spread, graded and the areas reclaimed. Today's cost for such an action would likely be several hundred million dollars. Re-establishing roadways and appurtenant works would be an additional cost. Permanent closure and elimination of the Cape Cod Canal would be contrary to the current Congressional authorization for this waterway. The USACE has no present authority to abandon the Canal and undertake such work. Due to the lack of authority and high cost to land and marine transportation from closing the Canal this alternative was not carried forward.

3.13 Alternative Plans Carried Forward for Detailed Analysis

In summary the several alternatives produce a variety of results when evaluated according to the screening measures, as shown in Table 5. Those that were beyond the USACE authority or otherwise failed more than one of the screening measures were eliminated from further consideration and were not carried forward for detailed analysis.

Table 5 – Initial Screening Summary

Alternative	Retains Functionality	Excessive Cost	Significant Impact	Maintains Navigation	Existing Authority
A – Fix as Fails	This is the Base Plan / No Action Plan				
B – Major Rehab	Yes	No	Yes	Yes	Yes
C – Replace In-Kind	No	No	Yes	Yes	Yes
D – Replace - 6-Lane	Yes	No	No	Yes	Yes
E – More Thru Lanes	Yes	Yes	No	Yes	No
F – Single Bridge	Yes	Yes	Yes	Yes	No
G – Third Bridge	Yes	No	No	Yes	No
H – Two Tunnels	Yes	Yes	No	Yes	No
I – Single Tunnel	Yes	Yes	No	Yes	No
J – Low Draw Spans	No	No	Yes	No	Yes
K – Causeways	No	No	Yes	No	No
L – Fill-in - Abandon	No	Yes	Yes	No	No

Four of the alternatives identified and discussed above were developed into detailed plans and will be carried forward for further analysis. Each of these plans is within the USACE existing authority for operation, maintenance, repair, rehabilitation and replacement of the Cape Cod Canal FNP project features. No new legislation would be required for implementation. Table 6 lists and describes the detailed plans. These detailed plans are:

(A) No Action – Maintenance and repair of both bridges continues without any major rehabilitation. Bridge components are repaired or replaced when inspections yield unsatisfactory reliability ratings.

(B) Major Rehabilitation - All known structural, mechanical, and electrical deficiencies will be addressed and obsolete components replaced for both bridges.

(D) Bridge Replacement including auxiliary acceleration/deceleration lanes for one or both bridges. A full replacement bridge will be built parallel to one or both existing bridges. Each new bridge will include four vehicle through-travel lanes and two auxiliary lanes to facilitate safe exit and entrance from the connecting surface roads. A pedestrian/bicycle lane would also be included on each bridge. The existing bridge(s) will remain in service until the new bridge(s) are completed.

Table 6 – List of Alternative Plans Carried Forward for Detailed Analysis

Plan	Description	Special Considerations
Base A	Continued Maintenance and Repairs to Both Existing Bridges as Needed to Maintain Safety (Fix as Fails)	This is the Federal Base Plan – the Without-Project Condition or the No Action Plan
B	A Program of Repairs and Major Rehabilitation for Both Bridges to Maintain Safety and Avoid Future Restrictions on Bridge Weight Postings	Major Rehabilitation of Each Bridge is Required about every 45 Years.
D	Replacement of One or Both Highway Bridges with New Bridges having Four Through-Traffic Lanes and Two Acceleration/Deceleration Lanes	Each Old Bridge would Remain in Service until the New Bridge was Completed

4.0 PROJECT BASELINE – THE EXISTING HIGHWAY BRIDGES

4.1 The Existing Bridges in General

The Base Condition is conceptually equivalent to the "without project" condition for new project evaluations in the sense that the benefits, costs, and impacts of all alternatives are measured by comparison to the Base Condition. For NEPA purposes, the Base Condition is the No Action condition. Both highway bridges are in deteriorated condition, well beyond the state in which actions and funding from the Operations and Maintenance Program could correct the deficiencies and restore and sustain reliability. In an operational sense, the underlying assumption of the Base Condition is that the bridges will continue to be operated and maintained without the proposed rehabilitation to any of their components. In the event of unsatisfactory performance of a bridge component, it is further assumed that emergency funding will be made available to make repairs and correct problems as they may arise.

Under the Base Condition, the reliability of the bridge is allowed to fall below the current level, however the bridge does remain functional.

Both of the existing highway bridges were built in 1933 to 1935 and are now nearing 85 years of service. The existing bridges undergo a regular cycle of inspection, the results of which guide maintenance and repair actions. While the bridges remain in fair condition, operations, maintenance and repair costs continue to escalate as the structures age. Lane closures for maintenance and repairs and other restrictions on vehicular passage will also increase with adverse impacts to traffic and access by emergency responders. Ultimately within the 50-year economic period of this study the two bridges will each separately reach the point where escalating repair needs force weight limit posting of the bridges.

The fix-as-fails base condition is meant to address health and public safety issues by capturing the items necessary to prevent a potential bridge failure. Even with continuing inspection and repair there is uncertainty regarding bridge failure, where a bridge is completely closed for a prolonged period. However, with a proper comprehensive program of inspection, repair and maintenance as needed the risk of failure of either bridge is low.

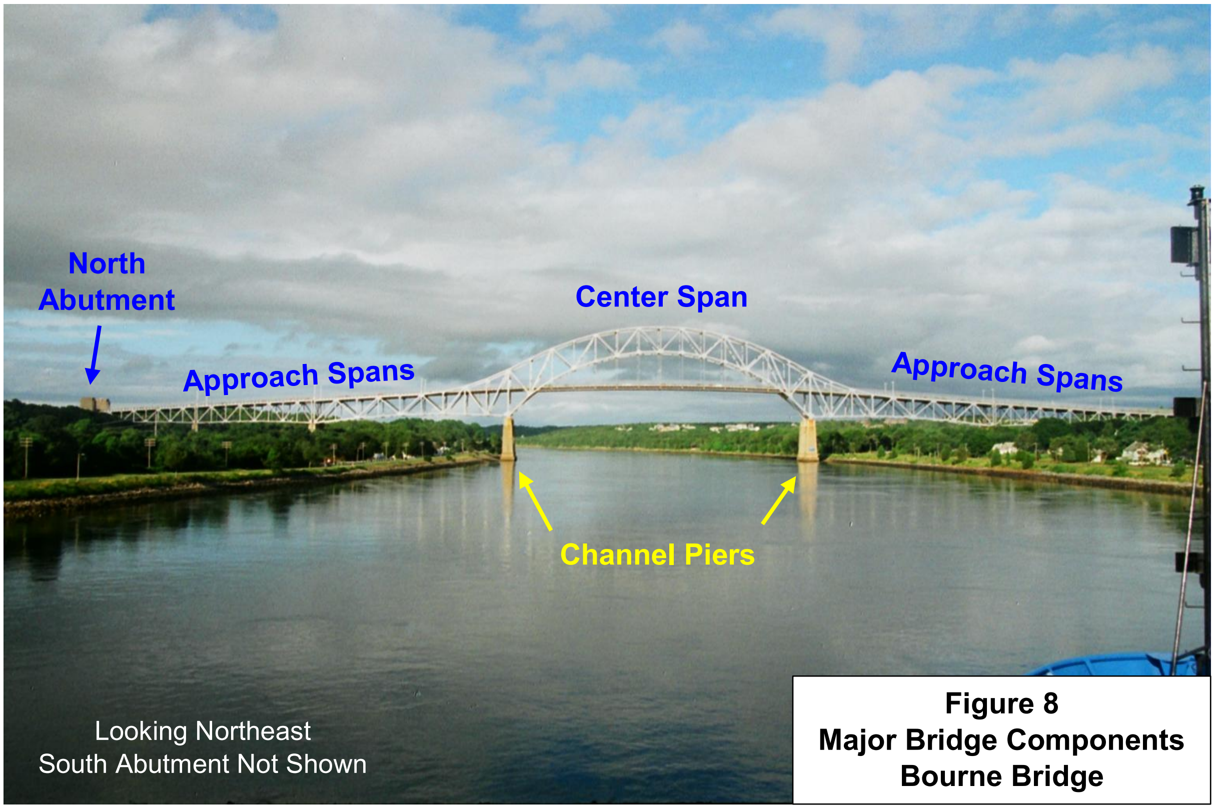
4.2 Bridge Maintenance and Repair History and Costs

Both highway bridges are of similar steel truss design, consisting of a center span over the waterway supported by concrete piers on each side of the channel, two main side spans to the north and south of the center span, and concrete abutments on shore. Additionally the Bourne Bridge includes four approach spans, two on each shore, between the main side spans and the concrete abutments. This gives the Sagamore Bridge a total of three spans, and the Bourne Bridge a total of seven spans. Both bridge center spans have a minimum vertical navigation clearance of 135 feet above mean high water over the width of the channel. Figure 7 shows the major components of the Bourne Bridge.

The center spans are through arch truss suspended spans with cables suspending the roadway deck from the arch. The main side spans are deck trusses. The abutments are reinforced concrete multi-chambers that connect with the roadways. A series of ladders, platforms and catwalks provide access for inspection and maintenance for the abutments, pier caps, floor system and truss arches. The decks are steel grids filled with five inches of concrete and topped with a 2 inch bituminous concrete surface.

Channel piers are located within the Canal and are atop pedestals which are on footings. Each pier is a pair of hollow concrete columns set on individual pedestals and joined at the top by a concrete strut. For both bridges each channel pier column is 24 feet square at the bottom tapering to 15 feet square at the top. For the Bourne Bridge the four piers between the approach spans are solid concrete columns 20 feet square at the base tapered to 14 feet square at the top joined by a tapered concrete strut. Design statistics for the existing highway bridges are shown in Table 7. The bridge superstructure and substructure are shown in Figure 8.

Table 7 – Existing Highway Bridge Design Dimensions		
	Bourne Bridge	**Sagamore Bridge**
Bridge Length (Feet)		
Center Span	616 Feet	616 Feet
Two Main Side Spans	396 Feet Each	396 Feet Each
Approach Spans	208 to 270 Feet Long (4)	None
North Concrete Abutment	150 Feet	200 Feet
South Concrete Abutment	150 Feet	225 Feet
Total Bridge Length	2,684 Feet	1,833 Feet
Decks		
Travel Lanes	Four 10-Foot Lanes	Four 10-Foot Lanes
Sidewalks	One 6-Foot 8-Inch Walk	One 6-Foot 8-Inch Walk
Brush Curb	One 2-Foot Curb	One 2-Foot Curb
Total Width between Curbs and Sidewalk	48 Feet 8 Inches	48 Feet 8 Inches



Looking Northeast
South Abutment Not Shown

Figure 8
Major Bridge Components
Bourne Bridge

Both highway bridges have had a typical maintenance, repair and rehabilitation history since completion of initial construction in 1935. Painting of the steel superstructure is required every five to ten years. The maintenance and repair history for the Bourne Bridge is presented in Table 8, and for the Sagamore Bridge in Table 9. Maintenance and repair of the two highway bridges represent a large portion of the Canal's annual operation and maintenance costs. Costs are contract costs only as taken from the Annual Reports of the Assistant Secretary of the Army for Civil Works for the years since the last major rehabilitation of both bridges beginning in 1981.

Table 8
Bourne Bridge Maintenance and Repair History

Year	Work Performed	Cost ($1000s)
1938	Painted superstructure	
1938	Sealed coated wearing surface - sheet asphalt	
1947	Painted superstructure	
1949	Replaced bituminous pavement	
1952	Painted superstructure	
1958	Painted superstructure	
1959	Replaced 4 anchor bolts (Piers 3 and 5)	
1963	Resurfaced roadway and sidewalk; new curbing; new scuppers; replaced 5-foot strip of deck concrete adjacent to the sidewalk and the brush curb; electrical work; concrete repairs; access ladders; platforms and downspouts	
1967	Painted superstructure	
1969	Pressure grouting of cracks in concrete abutments and piers	
1971	Painted railings	
1973	Painted superstructure	
1976	Repaired two stringers, Span 4; replaced sidewalk bracket, Span 1, removed bird droppings from abutments; removed two pairs of hanger cables for testing and replaced with new cables	
1979-1981	Removed existing deck and replaced with lightweight concrete filled steel grid deck; installed new waterproofing membrane and bituminous wearing surface; strengthened upper and lower bracing in Spans 4 to 7; repaired over 250 members; repaired or replaced over 200 gusset/stay plates; replaced approximately 3000 deteriorated rivets with high strength bolts; installed new roadway joints; and painted superstructure	$12,958
1984-85	Placed new waterproofing membrane on sidewalk and curb	$151
1985	Repair of Suicide Deterring Fencing	$44
1985	Emergency Repairs to Bourne Bridge Paving Surface	$7
1986-1987	New hanger cables installed; new drainage pipes installed; new waterproofing on curb; patched spalls and injected cracks on abutments, piers, and parapets; electrical work; painted superstructure	$2,775
1988-1989	Removed existing bituminous waterproofing membrane and top 1-1/2 inch of deck concrete on abutments; placed new 1-1/2 inch micro-silica overlay; new waterproofing membrane and bituminous concrete wearing surface. (Joint contract both bridges)	$428
1992	Painted superstructure.	$2,239
1997	Repaired/replaced deck joints at South Abutment, Pier 3 & North Abutment.	$25
1999	Replaced deck joint at Pier 4; major concrete repairs to abutments and piers.	

Table 8 - Bourne Bridge Maintenance and Repair History (Continued)		
1999-2000	Replaced concrete parapets; repaired sidewalk and curbs; replaced waterproofing membrane and bituminous wearing surface on deck and abutments; miscellaneous electrical work. (Joint contract both bridges)	$1,585
2001	Major substructure rehabilitation including: concrete spall repairs to piers, abutment seats, abutment chamber walls and bents and concrete stringer repairs within chambers.	$2,229
2004-06	Painted superstructure with work completed in 2006.	$8,476
2009-2010	Deck rehabilitation contract performed. Removed the existing asphalt pavement and waterproofing membrane on both abutments and the steel superstructure deck; repaired concrete substrate on abutments; repaved entire length of bridge with Rosphalt. (Joint contract both bridges)	$1,822
2010-2014	Steel repairs throughout the entire length of the bridge including gusset plate patch plates, replacement of sway bracing, replacement of missing rivets with bolts at member connections and lacing bar connection, removal of fatigue sensitive weld details on truss members, floorbeams and stringers and replacement of deck drainage support brackets with new drainage downspouts. $6.8 million (Joint contract combined with Sagamore Bridge Steel Repairs – Total $9.7 million).	$6,800
2019	Replace modular joint at Piers #3 & #4	$1,600
	Total Maintenance and Repair Cost 1979-2017	$41,139
	Annual Average 1979-2017 – 38 Years	$1,055

Table 9
Sagamore Bridge Maintenance and Repair History

Year	Work Performed	Cost ($1000s)
1938	Paint superstructure	
1938	Seal coated the wearing surface - sheet asphalt	
1942	Paint railings	
1947	Paint superstructure	
1952	Paint superstructure	
1955	Replace bituminous pavement	
1959	Replace roller nest at north abutment	
1962	Resurface roadway and sidewalk; new curbing; repair expansion joints; replace 5- foot strips of deck concrete adjacent to curbs; concrete repairs; new scuppers; electrical work	
1963	Paint superstructure. Additional access ladders and platforms, downspouts added to scuppers, repairs to catwalk under deck, replace railing bolts	
1964	10" Welded steel gas main installed beneath deck from abutment to abutment	
1969	Rehabilitate sidewalk and curb; repair substructure cracks	
1970	Door Repair	
1970	Paint Superstructure	
1974	Repair structural members, concrete, expansion joints, railings; misc. work	
1975	Hanger Cable Replacement	

Table 9 – Sagamore Bridge Maintenance and Repair History (Continued)

1976	Joint repair at expansion joint on south abutment	
1981-1982	Remove existing deck and replace with lightweight concrete filled steel grid on galvanized steel stay-in-place forms; add new preformed waterproofing membrane and bituminous concrete wearing surface; new concrete curbs and sidewalks; repair or replace approximately 200 steel gusset/stay plates; replace approximately 1,000 lacing bars; replace approximately 1,000 deteriorated rivets with new high strength bolts; place new deck joints; replace hanger cables; install suicide deterring fence; paint superstructure	$9,589
1982-83	Door Replacement	$6
1986	Patch spalls and inject cracks on abutments, piers and parapets	
1988-1989	Remove existing bituminous pavements, waterproofing membrane, and upper 1-1/2" of concrete from abutment deck surface; place new 3-1/2" microsilica concrete overlay and wearing surface (Joint contract both bridges)	$286
1990	Paint Superstructure	$833
1995	Replace deck joint between south abutment and Span 3 with modular type expansion joint	$219
1996-1997	Replace deck joint between north abutment and Span 2 with modular type expansion joint	$85
1999	Paint superstructure	$2,466
2000	Repair concrete abutments and piers; replace deteriorated catwalk grating. (Joint contract both bridges)	$1,056
2005	Miscellaneous Repairs	$171
2007	Replaced modular joint between South Abutment and Span 3	$74
2008	Minor maintenance repairs to catwalk	
2010	Installation of new bearing anchor bolt covers at both abutments	
2009-2010	Repave full width roadway (Rosphalt) and resurface sidewalk for Spans 1, 2 and 3 as well as for full length of both abutments. Replaced sidewalks and parapets on both abutments (Joint contract both bridges)	$5,749
2011 - 2013	Steel repairs throughout the entire length of the bridge including gusset plate patch plates, repairs to lateral bracing and sway bracing and their connections, replacement of missing rivets with bolts at member connections and lacing bar connection, removal of fatigue sensitive weld details on truss members, floorbeams and stringers and replacement of deck drainage support brackets with new drainage downspouts. $2.9 million (combined with Bourne Bridge Steel Repairs – Total $9.7 million)	$2,900
2012 - 15	Painting of bridge superstructure. Work completed in Dec 2015.	$12,483
2018	Replaced modular joint system & all supporting concrete at south abutment joint; replaced all compression seal joints. $1.7 million	$1,700
	Total Maintenance and Repair Cost 1981-2018	$37,617
	Annual Maintenance Average 1981-2018 – 37 Years	$990

Records are also kept by the District on costs for operation and costs for maintenance for each of the two bridges. This data is not specific to individual maintenance actions, contracts, or categories of operations expenses. Table 10 provides the available information on highway bridge operation and maintenance costs.

Table 10
Recent Operation and Maintenance Costs for the Two Highway Bridges

Year	Bourne Bridge		Sagamore Bridge	
	Maintenance	Operation	Maintenance	Operation
2010	$12,000	$231,000	$2,542,100	$58,600
2011	95,400	86,800	2,037,000	102,700
2012	117,300	33,900	207,800	
2013	38,200	369,700	8,186,000	161,600
2014	150,600	1,400	4,174,100	127,800
2015		319,200	709,200	
2016			8,400	252,300
2017		339,300		24,000
2018	103,200		251,800	249,400
Total	$516,900	$1,381,200	18,026,400	$976,400
Annual Average over 9 Years	$57,400	$153,500	$2,002,900	$108,500

Note: Years with no value stated represent years for which data is not available.

4.3 Current Condition and Reliability Analysis - Methodology

The process for engineering and economic analysis of the existing highway bridges, their rehabilitation, and alternatives to major rehabilitation follows a phased process. The existing bridge conditions are determined through various evaluations. The requirements for a program of major rehabilitation are developed and an estimate of the cost of implementing that program is determined. Requirements and costs for the various alternatives to major rehabilitation are then investigated and determined using the risk assessment principals of structural reliability analysis. The first three steps are discussed in this section.

1) Determine the current physical condition of the two highway bridges. Current and historical component condition ratings are identified for major structural components (deck, superstructure and substructure) using National Bridge Inspection Standards. A poor rating would lead to a determination of “structurally deficient”. Where the roadway no longer meets today’s minimum design standards it is determined “functionally obsolete”.

2) Determine likely future changes in physical condition using fatigue analysis and corrosion analysis. A load-induced fatigue analysis was conducted in accordance with current AASHTO standards and criteria. A corrosion analysis was conducted to aid in determining the overall long-term impact of corrosion on various bridge members, including the trusses, floorbeams, stringers and gusset plates, in relation to load rating factors over the 50-year study period.

3) Determine the requirements for a major rehabilitation program for each bridge. Develop a rough order of magnitude cost estimate for a program of major rehabilitation for each of the two bridges.

4.4 Current Physical Condition of the Highway Bridges

4.4.1 Criteria and Condition Rankings

The overall condition of both the Bourne and Sagamore highway bridges continues to worsen as the bridges age and major maintenance projects becomes more frequent. As the condition deteriorates, this leads to the bridges becoming structurally deficient. Both bridges are functionally obsolete and structurally deficient and are routinely unable to accommodate an efficient flow of traffic within the current State and local roadway network leading to the bridge approaches.

A functionally obsolete bridge is one that was built to standards that are not used today. Functionally obsolete bridges are those that do not have adequate lane widths, shoulder widths, or vertical clearances to serve current traffic demand, or those that may be occasionally flooded.

A structurally deficient bridge is one where significant load bearing elements such as the deck, substructure or superstructure are found to be in poor or worse condition. Deficient bridges require repair or rehabilitation to address deficiencies and are often posted with reduced weight limits on vehicles. The bridge components are shown in Figure 9.

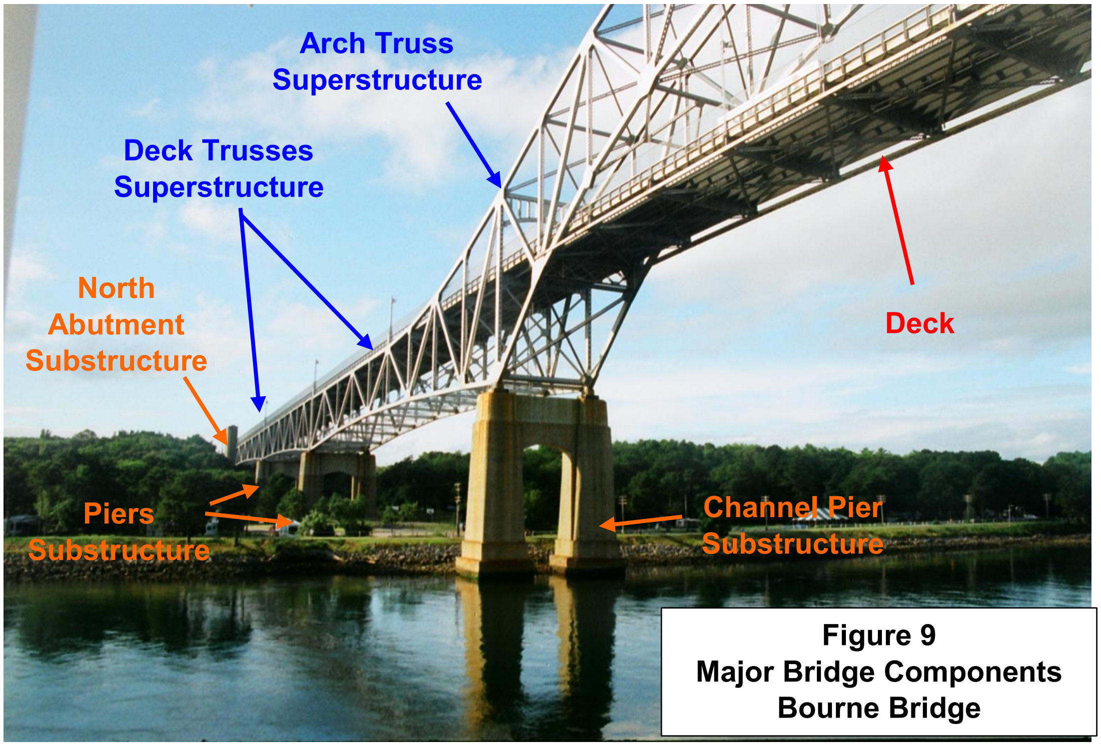

Arch Truss Superstructure
Deck Trusses Superstructure
North Abutment Substructure
Deck
Piers Substructure
Channel Pier Substructure

Figure 9
Major Bridge Components
Bourne Bridge

The Bourne and Sagamore Bridges are each inspected every 24 months according to the current National Bridge Inspection Standards (NBIS). The NBIS sets the national standards for the proper safety inspection and evaluation of all highway bridges in accordance with 23 U.S.C. 151 in order to ensure the safety of the traveling public. Inspections apply condition ratings to the various bridge components using the Federal Highway Administration (FHWA) *Recording and Coding Guide for the Structure Inventory and Appraisal of the Nation's Bridges*. Individual bridge components (see Figures 7 and 8) are assigned condition ratings on a scale of 0 (Failed Condition) to 9 (Excellent Condition), as shown in Table 11. Condition ratings are used to describe the existing, in-place bridge as compared to the as-built condition and to determine structural deficiency. Evaluation is for the materials and physical condition of the deck, superstructure, and substructure components of a bridge.

Table 11
Bridge Component Condition Ratings

Code	Description	Commonly Employed Feasible Actions
9	EXCELLENT CONDITION	Preventive Maintenance
8	VERY GOOD CONDITION No problems noted.	
7	GOOD CONDITION Some minor problems.	
6	SATISFACTORY CONDITION Structural elements show some minor deterioration.	Preventive Maintenance; and/or Repairs
5	FAIR CONDITION All primary structural elements are sound but may have some minor section loss, cracking, spalling or scour.	
4	POOR CONDITION Advanced section loss, deterioration, spalling or scour.	Rehabilitation or Replacement
3	SERIOUS CONDITION Loss of section, deterioration, spalling or scour have seriously affected primary structural components. Local failures are possible. Fatigue cracks in steel or shear cracks in concrete may be present.	
2	CRITICAL CONDITION Advanced deterioration of primary structural elements. Fatigue cracks in steel or shear cracks in concrete may be present or scour may have removed substructure support. Unless closely monitored the bridge may have to be closed until corrective action is taken.	
1	IMMINENT FAILURE CONDITION Major deterioration or section loss present in critical structural components or obvious vertical or horizontal movement affecting structure stability. Bridge is closed to traffic but corrective action may put back in light service.	
0	FAILED CONDITION Out of service, beyond corrective action.	

Appendix A contains a detailed description of both bridges, the results of the biennial bridge inspections, and a history of bridge condition ratings over time. A summary of these inspection results is provided below.

4.4.2 Bourne Bridge Physical Condition

The Bourne Bridge (as of the 2016 inspection) is both structurally deficient and functionally obsolete. The deck is in fair condition with a rating of 5 due to continuing deterioration of the deck in the abutment spans. The superstructure is in poor condition with a rating of 4 despite recent steel repairs and the removal of fatigue sensitive detail welds, due to continuing deterioration of truss joint gusset plates. The substructure remains in good condition with a rating of 7. Figure 10 shows the history of condition ratings for the Bourne Bridge since 1971, including the last major rehabilitation cycle in 1981. Table 12 provides a summary of the condition rating of these major components.

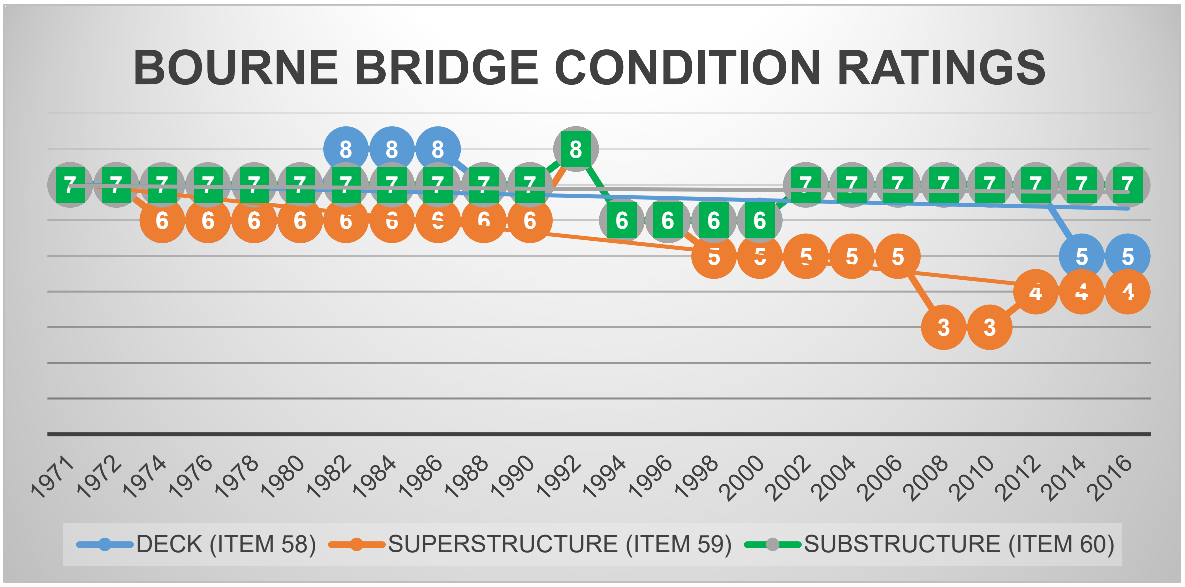


Figure 10 – History of Condition Ratings – Bourne Bridge

The bridge traffic safety features, including the bridge railing, transitions, approach guardrails and approach guardrail ends, do not conform to current AASHTO or MassDOT Specifications. These elements are thus rated as not meeting currently accepted standards.

The railings and anti-missile fence are composed of a nonstandard configuration and do not conform to current MassDOT standards. Additionally, there are areas with no positive connections at the transitions between the approach guardrails and the concrete end posts, and some of the w-beam approach guardrails do not conform to current MassDOT standards.

Table 12 – Bourne Bridge Component Condition Ratings		
Component	**Rating**	**Example Conditions**
Deck	5	Deteriorated deck area over the abutments. Deteriorated deck joints.
Superstructure	4	Gusset plates with significant section loss and deformation (five spans of the west truss and 3 spans of the east truss). Fatigue details on critical members and stringers. Pack rust, warping and section loss to truss members, stringers, and floor beams. Suspender cables and pain are in overall fair condition. The bridge seat is undermined at some of the concrete beams and there is scaling, spalling, and delamination of concrete beams in both abutments.
Substructure	7	Overall good condition. However there are some specific areas of deterioration including spalling, cracking, and delamination on abutment walls and struts
See Appendix A for complete report on Engineering Reliability		

4.4.3 Sagamore Bridge Physical Condition

The Sagamore Bridge (as of the 2017 inspection) is functionally obsolete and has been found structurally deficient as recently as 2011. The deck is in fair condition with an overall rating of 5. The superstructure and substructure are also in fair condition with overall ratings of 5. However individual bridge components warrant overall ratings of poor, such as the gusset plates and other connection plates. Figure 11 shows the history of condition ratings for the Sagamore Bridge since 1969, including the last major rehabilitation cycle in 1981. Table 13 provides a summary of the condition rating of these major components.

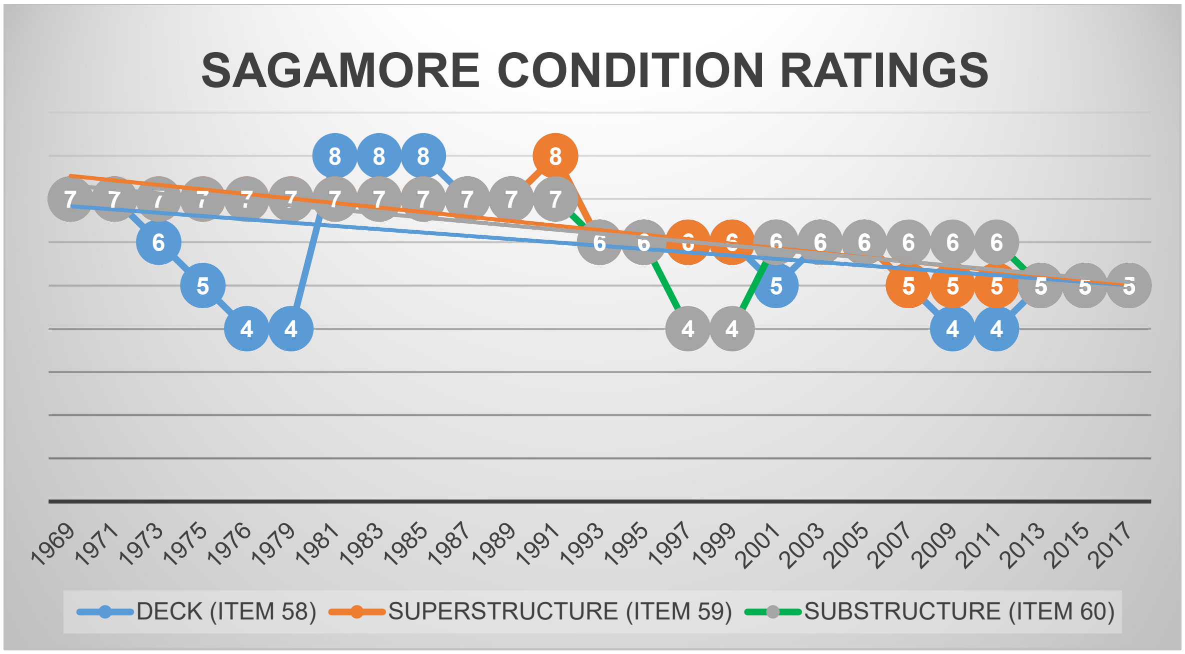


Figure 11 – History of Condition Ratings – Sagamore Bridge

4.4.4 Fatigue Analysis Summary

As part of this Engineering Reliability Analysis, a load-induced fatigue analysis was conducted in accordance with current AASHTO standards and criteria (*LRFD Bridge Design Specifications* (LRFD) and the *Manual for Bridge Evaluation* (MBE)). The fatigue analysis was conducted for truss members, floorbeams, and stringers. The fatigue analysis results indicated that all primary load carrying members of the truss or flooring system (floorbeams, stringers, etc.) have an infinite fatigue life. All of the fatigue sensitive details (FSDs); the trusses, floorbeams, and stringers are routinely monitored for cracks, and some do have a finite fatigue life. Section 5 of the Engineering Reliability Analysis Appendix presents a detailed discussion of the methodology and results of the fatigue analysis including load stresses, fracture toughness, and fatigue life.

Table 13 – Sagamore Bridge Component Condition Ratings

Component	Rating	Example Conditions
Deck	5	Deteriorated deck along the deck joint headers (spalling, exposed rebar, delamination). Deteriorated truss span deck along exterior stringers. Deck cracking on abutment spans. Vertical misalignment of the roadway at the south abutment span (Span 3 northbound). Spalling of reinforced concrete.
Superstructure	5	Gusset plates with significant section loss and deformation due to pack rust (three spans of the west truss and 2 spans of the east truss). South abutment bearings at end of expansion range. Bent anchor bolts. Fatigue details on critical members and stringer flanges. Pack rust, warping and section loss to truss members, stringers, and floor beams. Suspender cables and pain are in overall fair condition. Scaling, spalling, and delamination of concrete beams is seen in both abutments.
Substructure	5	Spalling, cracks, and delamination on south abutment walls.
See Appendix A for complete report on Engineering Reliability		

4.4.5 Corrosion Analysis Summary

A corrosion analysis was conducted to aid in determining the overall long-term impact of corrosion on various critical bridge members, including the trusses, floorbeams, stringers and gusset plates, in relation to load rating factors over the 50-year study period. Corrosion rates for this study were determined from measurements taken on fascia stringers of the Sagamore Bridge and on truss members and gusset plates of both the Sagamore and Bourne Bridges. The analysis determined an average corrosion rate of 0.0027 inches/year, which falls within the expected range of 0.002 to 0.003 inches for coastal areas with moderate salinity (See Appendix A – Engineering).

This corrosion analysis found that various main truss gusset plates will likely have rating factors less than 1.0 in ten to twenty years. Substantial costs will need to be incurred to replace or rehabilitate the gusset plates within the 50-year study period in order to prevent the bridges from being posted for weight restrictions. Further, both the stringers and the floorbeams will have reduced capacity that may result in the need to initiate weight restrictions on both bridges in 20 to 30 years, or less. It is also likely that overweight permits will also need to be restricted when the bridge is load posted.

Section 5 of the Engineering Reliability Analysis Appendix (Appendix A) presents a detailed discussion of the methodology and results of the corrosion analysis including rates of corrosion, application of those rates to critical members, and the impact of posting the bridges for weight restrictions within the 50-year period of analysis should no replacement and or rehabilitation of those critical bridge members take place.

4.5 Base Condition Fix-as-Fails Actions and Costs

Below in Table 14 are some of the types of repairs and the associated repair costs to various components and elements of the bridges which could possibly comprise this scenario of "fix-as-fails". It is not an all-inclusive list of potential issues, but these items should effectively cover the major components that would be expected to fail or at least need repairs under this scenario. These repairs could happened at any time in the project life cycle as various components fail.

Table 14 – Base Condition – Potential Repair Actions and Costs ($000s)

Bridge Component	**Sagamore Bridge**	**Bourne Bridge**
Superstructure:		
1. Advanced deterioration of secondary member, non-critical gusset plate, stringer, floor beam, or hanger cable	$6,600	$6,200
2. Advanced deterioration of main truss member or critical gusset plate	$15,300	$20,200
3. Catastrophic damage to main truss member or critical gusset plate	$310,300	$547,700
Bridge Deck:		
1. Localized deterioration of roadway joint(s), granite curbs, concrete-filled steel grid over bridge spans, or reinforced concrete deck at the abutments	$5,100	$5,800
2. Widespread deterioration of concrete-filled steel grid deck over bridge spans and reinforced concrete deck at abutments	$5,900	$7,600
Substructure:		
1. Localized concrete defects such as cracks or spalls on vertical surfaces of piers or degradation of concrete under bearings on piers	$400	$500
2. Widespread concrete defects such as cracks or spalls on vertical surfaces of piers or degradation of concrete under bearings on piers	$700	$1,100

Note: Potential component failures listed above are from the Engineering Reliability Analysis Appendix (A), page A-34. Also in Table D-6 in the Economics Appendix (D).

4.6 Base Condition Traffic Impacts

The emergency repairs under the Base Condition will have unscheduled impacts to surface and marine traffic. Though best efforts would be made to complete repairs outside of major holiday weekends and the tourist season this cannot be guaranteed and some impacts to those times are likely over the longer term. Table 15 below shows the potential component failures from Table 13 with the anticipated traffic impacts and costs of those failures should they arise.

Table 15
Base Condition Traffic Impacts and Costs (FY2020 - $000s)

Component and Failure Description	Traffic Impact	Sagamore Bridge Costs	Bourne Bridge Costs
Superstructure			
1	9 Months Lane Closures	$32,700	$21,100
2	18 Months Lane Closures	$321,200	$186,200
3	60 Months Bridge Closure	$10,343,400	$4,584,000
Bridge Deck			
1	6 Months of Temporary Lane Closures	$21,800	$14,100
2	15 Months of Temporary Lane Closures	$54,400	$35,200
Substructure			
1	6 Months of Lane Closures	$18,300	$13,400
2	12 Months of Lane Closures	$36,600	$26,700

* According to MassDOT trucks account for roughly 6% of traffic traveling over the bridges. Therefore 6% of traffic was rerouted as if full bridge closure for 12 months.

Traffic back-ups due to lane restrictions affect the connecting surface roads on both sides of the Canal. Higher summer and weekend traffic volumes compound the impacts. Average daily traffic volumes in 2014 (total for both bridges) fluctuate from a low of about 15,000 on winter weekend days to about 28,000 on summer weekend days. The Base Condition assumes a fix-as-fails scenario where repairs are made as needed to keep the bridges functioning. Under that existing or Base Condition the annual travel costs for vehicle delays in terms of time lost and increased fuel consumption due to traffic delays from unscheduled repairs total about $118.9 million for the Sagamore Bridge and $60.7 million for the Bourne Bridge (see Economic Appendix (D), Tables 21 and 22). These traffic delay costs results from running the Monte Carlo simulations on the component failure costs on the results of the table above.

5.0 STRUCTURAL RELIABILITY ANALYSIS

This structural reliability analysis serves as the probabilistic basis for an economic analysis that drives the decision making process by demonstrating the best economic alternative for addressing the deteriorating performance of the ageing Bourne and Sagamore Bridges. Reliability calculations are prepared for years 2016 to 2065, consistent with the prescribed 50-year service life for economic analysis. The highway bridges are features of the Cape Cod Canal Federal Navigation Project, and the period of analysis for navigation projects is 50 years. The three alternatives evaluated for reliability are: Plan A – the Base Condition, Plan B – Major Rehabilitation, and Plans C and D – Bridge Replacement.

5.1 Reliability Concepts

Reliability is defined as the probability that unsatisfactory performance will not occur. A "Limit State" is defined as the point at which unsatisfactory performance will occur or the engineering consequence will have some adverse economic impact. For this study, the limit state for unsatisfactory performance is defined as the physical condition where any of the bridges' critical elements is assigned a Condition Rating of 4 (Poor Condition) or less in accordance with protocols of the National Bridge Inspection Standard (NBIS).

Defining unsatisfactory performance based on the physical condition of the bridges using NBIS Condition Rating codes provides a viable way of determining a set of data points necessary for the regression analysis. USACE has historic data pertaining to the condition rating codes and this data can also be extrapolated for further analysis. In addition, this type of data is consistent with information in the national bridge inventory where data from similar types of bridges of similar age and environment can also be used for comparison purposes. Detailed analysis is provided in Appendix A – Engineering Reliability.

5.2 Deterioration Models

The overall reliability of the bridges is governed by three critical elements: superstructure, bridge deck, and substructure. Unsatisfactory performance of one or more of these critical elements would lead to unsatisfactory performance of the entire bridge. In order to assess the engineering reliability of the bridges, a probabilistic hazard function was developed for each of the three critical elements. The hazard function describes the probability of failure during a very small time increment, assuming that no failures have occurred prior to that time.

For each critical element, a two-parameter (defined by a shape parameter and a scale parameter) Weibull Probability Distribution was developed to predict deteriorating bridge element performance over a fifty-year service life. The two parameter Weibull is often used in failure analysis, because no failure can happen before time zero. The Weibull Probability Distribution is well accepted in academia and engineering literature as a methodology for assessing reliability and failure rates.

For the superstructure and bridge deck, the NBI database was queried for bridges of similar construction and age to that of the Bourne and Sagamore Bridges located in New England, New York, and over the Chesapeake-Delaware Canal, which are geographic areas with similar environmental exposures.

Since data for substructure elements are not easily searchable in the NBI database, standard data points adopted by the U.S Army Corps of Engineers' Risk Management Center were used for the substructure deterioration model. These data points represent conglomerate data points for reinforced concrete locks, walls, and bridge piers. The Weibull Distribution parameters used for each of the three critical elements, are the shape parameter, β (which is equal to the slope of the line in a probability plot) and the scale parameter, η, is greater than 1, this indicates that the failure rate increases with time. This happens if there is an "aging" process, or parts that are more likely to fail as time goes on.

Weibull Cumulative Distribution Function (CDF) and hazard rates developed for superstructure, decks, and substructure are presented in Appendix A - Engineering Reliability Analysis and an example for the Base Condition is shown in Figure 12 below. Weibull CDF is the probability of an event occurring within the time "t". The hazard rate is a conditional failure rate in relation to the reliability of a system or component.

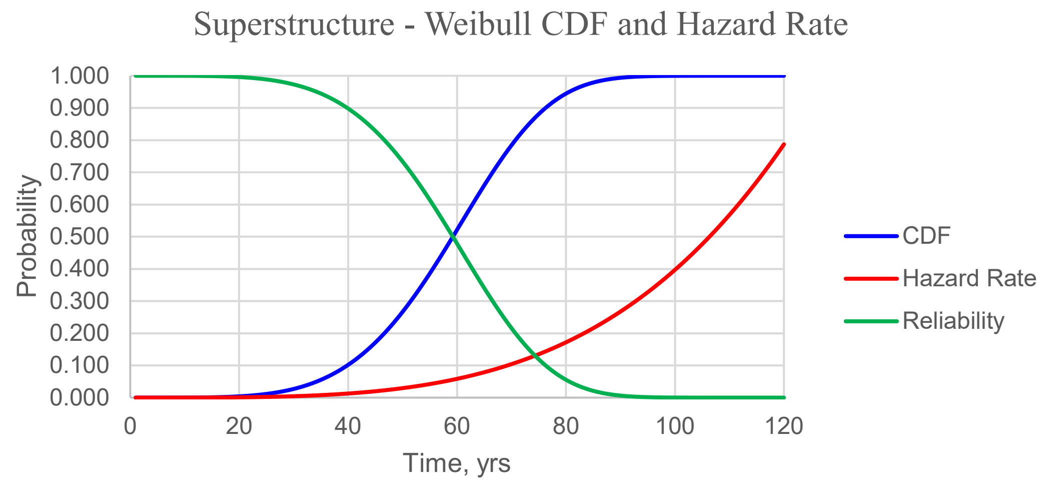
5.3 Reliability of Alternatives

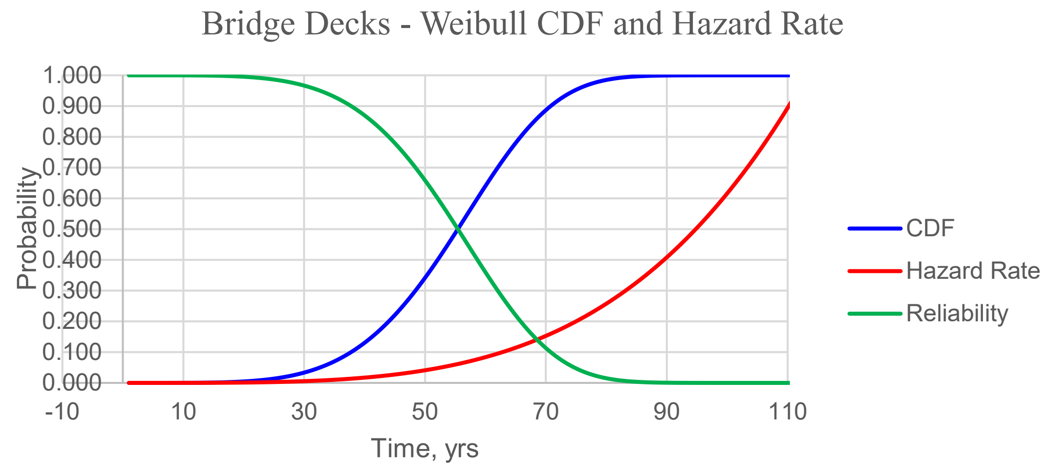
Base Condition: Major Rehabilitation of both the Bourne and Sagamore Bridges was completed circa 1981. For development of the deterioration model, it is assumed that the rehabilitation of the superstructure extended the service life by twenty years. Since the bridge deck was replaced completely as part of the major rehabilitation, the time variable is reset to zero in year 1981. No adjustment of the time variable for the substructure was made since only routine maintenance consisting of crack sealing and spall repairs has been performed over the life of the bridges.

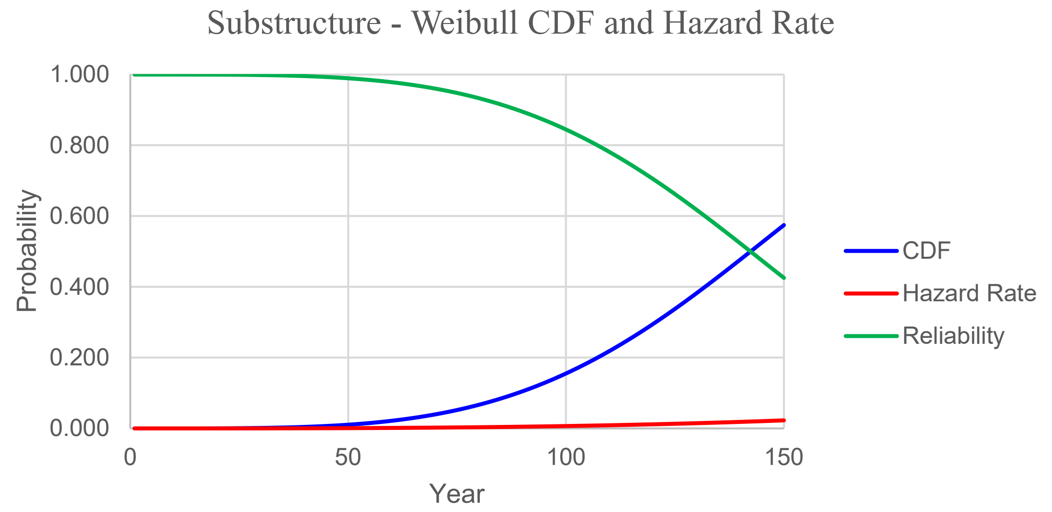
Major Rehabilitation: For the Major Rehabilitation alternative, a postulated major rehabilitation of the two bridges in the years 2025-2031 is assumed to extend the service life of the superstructure and substructure by an additional twenty years and reset the time variable for the bridge deck to zero at the beginning of those rehabilitation efforts.

Bridge Replacement: For the Bridge Replacement alternative, the time variables for computing the reliability of the superstructure, bridge deck, and substructure are all reset to zero at the beginning of the replacement work.

Figure 12 – Example Weibull CDF and Hazard Rates – Base Condition


Superstructure - Weibull CDF and Hazard Rate


Bridge Decks - Weibull CDF and Hazard Rate


Substructure - Weibull CDF and Hazard Rate

5.4 Consequence of Unsatisfactory Performance

The consequences of unsatisfactory performance, defined for this study as an NBI Condition rating equal to, or less than, 4 (Poor Condition) for the superstructure, bridge deck, or substructure on either bridge, are presented on an Event Tree for each critical element under each alternative. The event trees portray the full range of consequences caused by incidents ranging from localized structural defects to the remote probability of catastrophic damage. In addition to the contract costs for repair work, the economic factors associated with unsatisfactory performance predominantly are the delays to vehicular traffic and commercial marine vessels navigating the Cape Cod Canal.

Figure 13 shows example Event Trees for the three major bridge components for the Sagamore Bridge Base Condition. Appendix A – Engineering Reliability Analysis, provides the data and event trees for all of the final alternatives and their components.

All repair work on the superstructure and bridge deck require vehicular lane closures to facilitate contractor activities. Typically, these lane closures restrict travel to one lane in each direction. Historically, temporary lane closures have been in effect for a minimum of approximately nine months during the course of repair contracts. Full closure of the bridge will be required for shorter time periods (about 2 weeks) multiple times during a major rehabilitation to allow critical replacement of certain critical bridge components, such as interior gusset plates and floorbeams.

Repairs to the substructure (bridge piers) would require closure or delays to commercial marine vessels in additional to limited vehicular lane closures. The abutments for both bridges can be accessed from land-based construction methods and would not impact marine vessels.

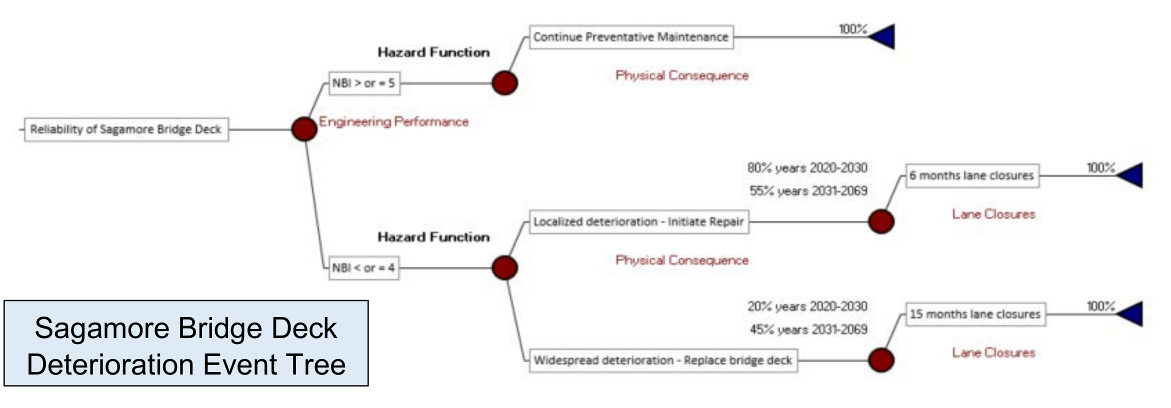
5.5 Results of the Reliability Analysis

A comparison of the cumulative reliability of the superstructure, bridge deck, and substructure for each of the alternatives at the end of the 50-year period (2016-2065) for reliability analysis evaluation is summarized in the table below.

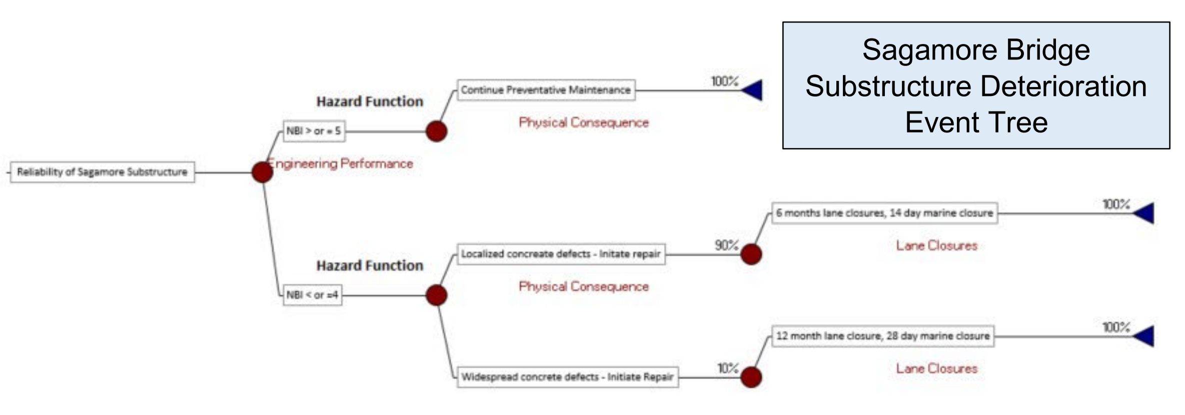
Table 16
Cumulative Reliability of Bridge Elements in 2065

Bridge Element	Base Condition	Major Rehabilitation	Bridge Replacement
Superstructure	0.000	0.006	0.733
Bridge Deck	0.005	0.659	0.659
Substructure	0.617	0.781	0.990
1 is most reliable, 0 is least reliable			

Figure 13 – Event Tree Examples – Sagamore Bridge – Base Condition

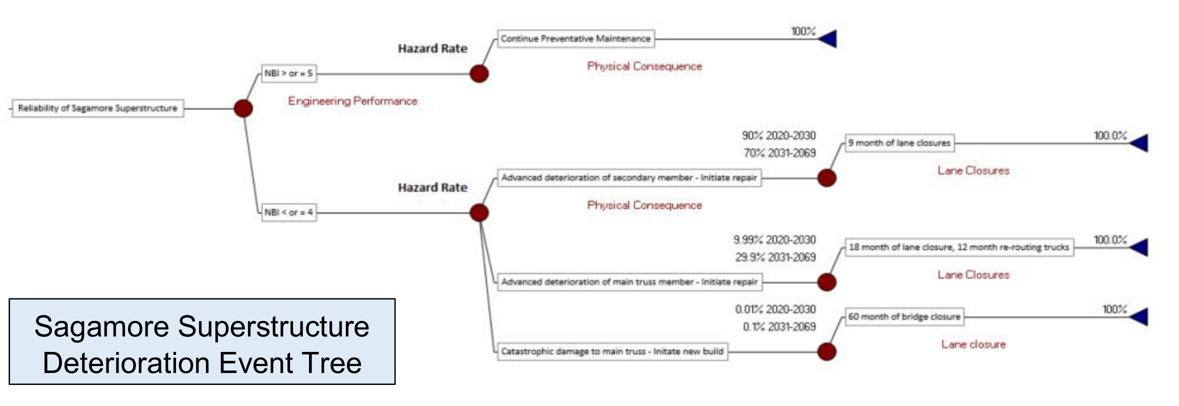


Sagamore Bridge Deck Deterioration Event Tree



Sagamore Bridge Substructure Deterioration Event Tree

Reliability of Sagamore Substructure
Engineering Performance
Hazard Function
NBI > or = 5
Continue Preventative Maintenance
100%
Physical Consequence
Hazard Function
NBI < or =4
Localized concreate defects - Initate repair
90%
6 months lane closures, 14 day marine closure
100%
Lane Closures
Physical Consequence
Widespread concrete defects - Initiate Repair
10%
12 month lane closure, 28 day marine closure
100%
Lane Closures



Sagamore Superstructure Deterioration Event Tree

Reliability of Sagamore Superstructure
Engineering Performance
Hazard Rate
NBI > or = 5
Continue Preventative Maintenance
100%
Physical Consequence
Hazard Rate
NBI < or = 4
90% 2020-2030
70% 2031-2069
Advanced deterioration of secondary member - Initiate repair
9 month of lane closures
100.0%
Lane Closures
Physical Consequence
9.99% 2020-2030
29.9% 2031-2069
Advanced deterioration of main truss member - Initiate repair
18 month of lane closure, 12 month re-routing trucks
100.0%
Lane Closures
0.01% 2020-2030
0.1% 2031-2069
Catastrophic damage to main truss - Initate new build
60 month of bridge closure
100%
Lane closure

A review of the predicted reliabilities in this table indicate that the Base Condition alternative yields the lowest reliability for all three of the critical elements. The deterioration model predicts with near certainty that both superstructure and bridge deck will be performing unsatisfactorily at the end of the 50-year period of evaluation.

The 85 year old steel bridges are beyond their functional service life. Both of the highway bridges can be maintained to prolong their overall structural integrity, but both are functionally obsolete. The Base Condition would create troublesome situations during the 50-year study period. For example, at some point the bridges will need to have weight restrictions, and likely undergo emergency structural repairs, which may or may not have an impact on load postings. Emergency maintenance is costly and could lead to major traffic issues at uncertain times of the year. Delays, closures, and load postings associated with the Base Condition would have adverse economic impacts on the region's businesses.

A Major Rehabilitation project will have socio-economic impacts on the surrounding region due to long-term ongoing traffic delays and disruptions. Even with major rehabilitation the Bourne and Sagamore bridges are not suitable in the long term as primary links in the highway system of southeastern Massachusetts and Cape Cod.

The engineering reliability analysis shows that the Bridge Replacement alternative offers the highest reliability of the three alternatives. Bridge replacement yields a higher reliability for the superstructure and substructure than major rehabilitation. The superstructure reliability of 0.006 for major rehabilitation makes this alternative a poor investment option.

6.0 MAJOR REHABILITATION

6.1 The Major Rehabilitation Alternative in General

This section will present and evaluate Plan B - major rehabilitation of each of the two highway bridges over the Cape Cod Canal. The expected performance, reliability and engineering risk of the major rehabilitation alternative will be considered and compared to the base plan to determine relative effectiveness, cost and impacts towards meeting the planning goals to provide safe and reliable long-term vehicular access across the Cape Cod Canal.

Plan B consists of implementing a program of repairs and major rehabilitation for both highway bridges to maintain safety and reliability over the 50-year planning horizon and avoid future restrictions on bridge weight postings. All known structural, mechanical, and electrical deficiencies will be addressed and obsolete components replaced for both bridges. More than one major rehabilitation program would be required; one at the beginning and one near the end of the planning horizon.

As with the Base Condition, the three major highway bridge systems that were analyzed for engineering reliability of each bridge are the substructure, superstructure and deck.

6.2 Major Rehabilitation Actions

Major rehabilitation projects are large scale structural improvements that are performed less frequently, outside of the purview of normal maintenance, and are aimed at prolonging the service life of the bridge, maintaining an acceptable load carrying capacity, and preserving overall public safety on the structure. This scenario assumes that all known structural deficiencies on both bridges will be addressed under a major rehabilitation contract. It is estimated that a full rehabilitation project would take 3 to 4 years for each bridge. Due to the need to divert traffic between two bridges during rehabilitation, to maintain sufficient traffic capacity, and lessen adverse impacts to traffic throughout the rehabilitation duration, only one bridge would be worked on at a time. This would result in an overall six to eight-year construction period for the rehabilitation of both bridges. Managing traffic impacts will be a considerable effort especially as some aspects of a major rehabilitation, such as replacement of interior gusset plates, will likely require complete bridge closure.

The scope of a major rehabilitation project is projected to include the following actions for each highway bridge:

1) Truss Span Deck Replacement: The lightweight concrete filled steel grid deck was replaced in 1979 on the Bourne Bridge and 1981 on the Sagamore Bridge. A typical service life for this type of deck is 40+ years. Replacement of the deck would require frequent and lengthy lane closures and would run concurrent with major steel repairs below the deck.
2) Stringer Replacement/Repair: The current stringers are in overall fair condition for both bridges, except for the fascia stringers, some of which exhibit significant pitting and section loss to the bottom flanges. Numerous original stringers were replaced during the deck replacement projects for both bridges in 1979 and 1981. Fascia stringer replacement would take place in conjunction with a deck replacement project.
3) Floorbeam Repair: The floorbeams are in fair condition on both bridges, though floorbeams under the joints are vulnerable to corrosion due to leaking of failed bridge joints. No floorbeams have been replaced on either bridge, but the recent steel repair project in 2012 included repairs to some floorbeams, and the extent of required floorbeam repairs will increase as the bridges continue to age. Repairs would likely include the addition or replacement of cover plates and the removal of any fatigue sensitive details.
4) Suspender Cable Replacement: The suspender, or hanger, cables were replaced in 1981 on the Sagamore Bridge and in 1986 on the Bourne Bridge. There at 13 pairs of cables per side of each bridge. Temporary jacking beams are required to remove cable pairs. This work can be done with the deck replacement project. Cables such as this typically have a service life about 50 years, but the service life varies based on the environment and loading experienced by the cables. Over time, degradation and elongation of the bridge cables will determine the need for replacement.
5) Replace Abutment Spans: The concrete T-beams are in poor condition at the Bourne Bridge, and in fair condition at the Sagamore Bridge. The T-beams were repaired in 1999-2001 at both bridges, but these repairs were localized. Rehabilitation will require

extensive concrete repairs to the beams to maintain their overall structural integrity. Complete replacement is required in order to significantly increase the service life of these elements. Beyond the T-beams, one-third of the area of the concrete deck of the abutments at the Sagamore Bridge is in poor condition. The Bourne Bridge abutment concrete deck is in overall good condition. The concrete deck on the abutments has been repaired numerous times since original construction of the bridges and currently much of the deck is deteriorated, which results in premature failure of any pavement overlay. The decks require replacement to regain the overall integrity of the abutment spans which should be undertaken at the same time as a truss span deck replacement project.

6) Bearing Repairs: The bearings are in overall poor condition at both bridges. There are 24 bearings at the Bourne and 8 at the Sagamore. Repairs would include any necessary seismic retrofits as well as installing new anchor bolts.

7) Joint Replacement: At the Sagamore Bridge, the modular joint system at the south abutment installed in 1995 was in serious condition due to spalling of the concrete supports, deterioration of the support bars, and vertical misalignment. This joint and supporting concrete was replaced in 2018 along with all of the compression seal joints. At the Bourne Bridge, the Pier 3 deck joint exhibits significant deflection under live loads and general deterioration throughout. This joint was partially repaired in 2010. The modular joint at Pier 4, repaired in 2005, is now deteriorated, misaligned, and has broken splice keys. Both Pier 3, Pier 4, and all the compression joint seals were replaced in the spring of 2019. The compression strip seals were all replaced in 2010 and on both bridges are now dislodged, missing, torn, or generally damaged and deteriorated.

8) Minor Steel Truss Repairs: Minor steel repairs would include additional work similar to the steel repair project completed in 2011-2013 for both bridges. This would include further exterior gusset plate retrofits on the main truss members, as well as repairs to some of the main truss members, secondary bracing, floorbeams, and stringers

9) Major Steel Truss Repairs: Major steel repairs would include the replacement of various members, as needed. This would include complete replacement of floorbeams and interior gusset plates. Replacement of major supporting elements such as floorbeams would require complete bridge closure during the replacement process. Replacement of interior gusset plates would require an extensive temporary support system during which each bridge would be closed to all traffic, although not concurrently. Other work would require periods of extensive lane closures. Only one bridge would be worked on at any one time.

10) Paving (Overlay): While paving in itself is not a major rehabilitation item, it would be included as part of an overall Major rehabilitation project. Paving was last accomplished in 2010 for both bridges. Paving would be done in conjunction with the deck replacement project.

11) Painting of Structural Steel: Both bridges have undergone complete paint removal (de-leading); the Bourne in 2006 and the Sagamore in 2014. While painting in itself is not a major rehabilitation item, it would be included as part of an overall major rehabilitation project. Active corrosion results in section loss and decreased load capacity of the members. Painting of the bridges is the single best method for preserving the current condition of the structural steel. Maintenance painting is required about once every seven years.

The estimated costs for rehabilitation or each bridge, by project component/feature necessary to arrest further component deterioration, restore bridge reliability, and defer future capital costs for replacement are shown in the table below. Further detail is provided in Appendix C – Cost Estimates, and comparison with the cost of other alternatives is provided in subsequent report sections.

Table 17
Major Rehabilitation Costs – Bourne and Sagamore Bridges

Item/Component	Bourne Bridge 2029-2031	Sagamore Bridge 2025-2027
Construction Cost – FY2020 (October 2019 Price Levels – Revised March 2020)		
Truss Span Deck Replacement	$30,734,000	$19,884,000
Suspender Cable Replacement	$10,428,000	$10,895,000
Replace Abutment Spans	$7,989,000	$8,347,000
Bearing Replacement	$3,525,000	$1,189,000
Joint Replacement	$1,974,000	$2,017,000
Steel Truss Repairs	$9,364,000	$6,311,000
Major Steel Truss Repairs	$28,432,000	$20,436,000
Paving (Overlay)	$3,286,000	$2,386,000
Complete Painting of Structural Steel	$17,444,000	$21,837,000
Subtotal	$113,176,000	$93,302,000
Contingencies (43%)	$48,665,000	$40,120,000
Total Contract Cost	$161,841,000	$133,422,000
Real Estate Interests (None Required)	- - -	- - -
Utility Relocation Costs	$12,749,000	$12,749,000
Planning, Engineering and Design	$8,212,000	$6,770,000
Construction Management	$3,369,000	$3,360,000
Total Project Cost	$186,171,000	$156,301,000
Future Post-Rehab Major Repairs and Third Rehabilitation (Bourne/Sagamore)		
Maintenance – Complete Painting (2049/45)	$26,827,000	$33,425,000
Major Rehab – Truss Deck, Floorbeams, Major Steel, Complete Paint, & Joint Replacement (2069/2065)	$132,120,000	$110,940,000
Subtotal Future Rehab and Repairs	$158,947,000	$144,365,000
Total Rehabilitation and Major Repairs	$345,118,000	$300,666,000

Table 17 – Major Rehabilitation Costs – Bourne and Sagamore Bridges (Continued)		
Future Post-Rehab Maintenance and Minor Repairs (O&M) (Bourne/Sagamore)		
Maintenance – Painting (2036/2032)	$9,036,000	$11,213,000
Maintenance – Joint Replacement (2037/2033)	$3,807,000	$3,877,000
Maintenance – Painting (2043/2039)	$9,036,000	$11,213,000
Paving and Joint Replacement (2044/2040)	$9,179,000	$7,832,000
Maintenance – Joint Replacement (2051/47)	$3,807,000	$3,877,000
Maintenance – Painting (2056/2052)	$9,036,000	$11,213,000
Paving and Joint Replacement (2059/2055)	$9,179,000	$7,832,000
Maintenance – Painting (2063/2059)	$9,036,000	$11,213,000
Total MR&R over 50 Years	$62,116,000	$68,270,000
Total Project Cost – Rehabilitation and Future Maintenance, Repair and Rehabilitation		
Total Project Cost	$407,233,000	$368,936,000
See Appendix C for detailed cost estimates		

For the purpose of allocating post-rehab costs to major repairs and rehabilitation versus maintenance and minor repairs, the two most expensive and technically involved actions were assigned to the former category and the remaining eight actions to the latter category. These categories will be separately discounted and averaged for the economic analysis.

6.3 Service Disruptions and Emergency Repairs

The Bourne and Sagamore highway bridges provide the only access to Cape Cod for vehicular, pedestrian and other non-marine traffic. There are no ferries from the mainland to the Cape other than the passenger ferries from Boston to Provincetown which mainly carry summer day tourists. The Cape bridges also provide the only access to the ferry terminals at Woods Hole and Hyannis which serve the islands of Martha’s Vineyard and Nantucket, with the exception of a seasonal cargo ferry from New Bedford to Martha’s Vineyard. Bridge maintenance, repair and rehabilitation actions which require lanes closures would have adverse impacts on the flow of traffic, cost of transporting passengers and goods, air quality and other impacts.

6.3.1 Vehicular Traffic Management during Major Rehabilitation

Traffic management will be a major task during a major rehabilitation project. It would likely include multiple and lengthy lane closures throughout the duration of the project and extended times where complete bridge closure would be required. This study did not analyze specific traffic control requirements or timeframes, so a generalized approach was used to provide an overall concept of what traffic management may be required for such a project. Table 18 summarizes lane closure and full bridge closure timeframes for a major rehabilitation of the

Bourne and Sagamore Bridges. These are strictly gross estimates based on engineering judgment and similar previous work done at the bridges.

TABLE 18
Anticipated Traffic Management Requirements for Lane and Bridge Closures

Major Rehabilitation Activity	Bourne Bridge	Sagamore Bridge
	Lane Closure Duration (Days)	
Bridge Superstructure Deck Replacement (Including Stringer Replacement) Abutment Span Replacement (Concrete T-Beams) Miscellaneous Steel Repairs, etc. Exterior Gusset Plate Retrofits Interior Gusset Plate Repairs Miscellaneous Concrete Repairs, etc.	165	135
Suspender Cable Replacement	65	70
Paving	30	25
Painting	220	150
Total Days of Lane Closures	480	380
Major Rehabilitation Activity	Full Bridge Closure Duration (Days)	
Interior Gusset Plate Replacement	70	95
Floorbeam Replacement	110	35
Total Days of Full Bridge Closure	180	130

The impacts of lengthy lane closures will be most extensive for bridge superstructure and deck replacement and replacement of the abutment spans (T-Beams and concrete deck). Timeframes for items requiring full bridge closure will have enormous impacts on the local traffic pattern and likely the local economy, even if for just short lengths of time. Of course, weather delays, particularly during the winter months, would extend the duration of any project. It is assumed that weather delays could account for 15-30 days during the winter months, based on past efforts.

6.3.2 Navigation Traffic Management during Major Rehabilitation

The Cape Cod Canal has significant value to navigation in the northern Atlantic seaboard. The Canal shortens the transit distance and time between points northerly and southerly of Cape Cod and increases the safety of navigation. Trips between New York and Boston, Providence and Boston, and New Haven and Boston benefit the most, but all traffic that can be accommodated in the canal's 32-foot channel depth benefits significantly. Each year the canal is used by more than 3,000 cargo vessels, at least 750 fishing vessels, 150 – 200 military vessels, and more than 4,000 recreational vessels, all of which benefit substantially from the shorter and safer travel route. The largest commercial vessels which transit the US east coast, such as large oil tankers and containerships, typically have drafts too deep to use the canal and are not affected. But other large commercial vessels with drafts of 30 feet or less such as cruise ships and auto carriers use the Canal on a regular basis.

Without the Canal in place, or with the waterway closed to traffic or its use restricted due to bridge work, vessels would have to travel the longer distance around the arm of Cape Cod, incurring increased transportation costs and increased risk of adverse weather conditions. Elements of the navigation value provided by the canal include benefits to cargo shipping, benefits to recreational vessel operators, and benefits to other types of vessels including cruise ships and military vessels. In all cases, the navigation benefits of the canal include reduced transportation costs and enhanced safety. Safety benefits can include damages prevented to vessels as well as the potential for prevention of loss of life.

There would be minimal delays to marine navigation throughout the duration of a major rehabilitation project. Barge mounted cranes would likely not be necessary and were not used during the last major rehabilitation of both the Bourne and Sagamore Bridges in 1979 to 1981. That work consisted of replacement of the bridge decks, replacement and repairs to deteriorated stringers, replacement of hanger cables, repair of secondary members, replacement of corroded rivets and lacing bars, and painting of the superstructure. While the actions contemplated for this next major rehabilitation will be more extensive, no additional impact on vessel navigation through the Canal is anticipated.

7.0 BRIDGE REPLACEMENT ALTERNATIVES

This section presents and evaluates the alternatives to major rehabilitation of the two highway bridges. The expected performance, reliability and engineering risk of each alternative will be considered and compared to the base plan to determine relative effectiveness, cost and impacts towards meeting the planning goals to provide safe and reliable long-term vehicular access across the Cape Cod Canal.

7.1 Bridge Replacement in General - Concept Level Alternatives

A new bridge type and design have not been accomplished for this study. Bridge replacement has been developed and evaluated at a concept level to weigh the costs, benefits, reliability, safety and risk relative to the Base Condition and the Major Rehabilitation Alternative for each bridge. The bridge replacement scenario postulates that new vehicular bridges will be constructed to replace each of the two existing highway bridges. One new bridge would be constructed parallel to the existing Bourne Bridge and the other parallel to the existing Sagamore Bridge. The existing Bourne and Sagamore Bridges would remain in service until the new bridges are constructed. For purposes of this Phase I study, a cable-stay bridge alternative concept was investigated and bridge location was assumed to be immediately next to and inshore of each existing bridge. The study area assumed for bridge replacement at each site is shown in Figure 14. Any bridge replacement would require further investigation to ascertain the most economical and favorable bridge type. The final bridge alignments, heights, grades, and overall configurations will likely be different from what is evaluated in this study.

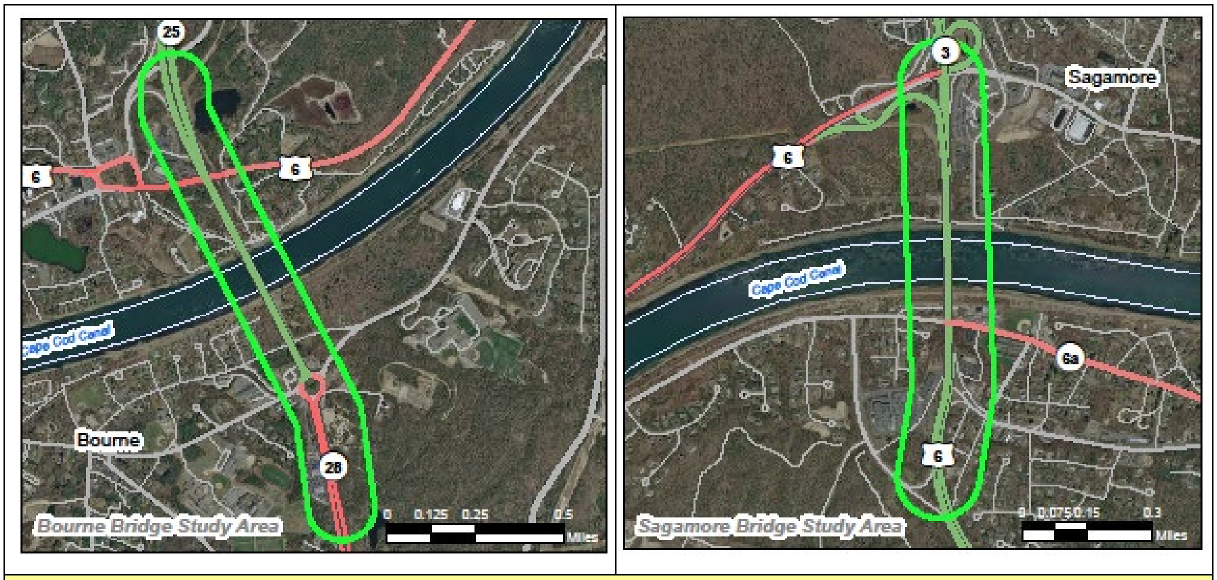


Figure 14 – Concept Level Siting Areas for Replacement Bridges

The conceptual cable-stay bridge alternative presented here was based on the SR-1 Bridge over the Chesapeake and Delaware Canal at St. Georges, Delaware (Senator William V. Roth Jr. Bridge) constructed in 1992-1995. This bridge type was chosen for this study, in part, because it is a USACE owned bridge over a marine navigation canal (the Chesapeake and Delaware Canal) of similar proportions to the Cape Cod Canal. It provides an alternative similar to what would be required for a new bridge to cross the Canal. The Roth Bridge is 4,650 feet long and carries a total of 6 traffic lanes.

There is one replacement alternative for each bridge after initial screening. This alternative, Plan D would provide four through traffic lanes plus two auxiliary (acceleration/deceleration) lanes for access and exit to the adjacent surface roads. This plan is described as follows:

Plan D – Replacement with Safety Modifications – Replacement of one or both highway bridges with new bridges each having four through-traffic lanes and two auxiliary acceleration/deceleration lanes, plus a pedestrian/bicycle lanes in accordance with modern highway standards. A full replacement bridge would be built parallel to one or both existing bridges which would remain in service until the new bridge is completed. The new bridges would be designed to modern highway standards in terms of lanes widths, medians, shoulders, grades, pedestrian and bicycle lanes and lane separation. The ramps to/from these roads are located immediately shoreward of the bridge abutments. The addition of auxiliary lanes in each direction of travel would facilitate safer exit and entrance from the connecting surface roads and would comply with FHWA and MassDOT highway and bridge design standards as noted earlier. This design would provide two unimpeded through-traffic lanes in each direction. Traffic safety would be improved by easing the effects of merging of entering and exiting traffic on through traffic.

7.2 Sea Level Change Impacts on New Bridge Design

The potential for future sea level change over the next 50 and 100 years must be examined to ensure adequate air gap clearance for navigation is maintained. The Canal, including its approaches, extends from Cleveland Ledge Light in Buzzards Bay to approximately 1.4 NM seaward of the canal's eastern end breakwater light in Cape Cod Bay, a distance of approximately 15.5 NM. The land cut portion of the canal, between the Cape Cod Canal Traffic Control Center in Buzzards Bay and the East Mooring Basin in Sandwich, is approximately 5.9 NM in length, or 7.7 miles from the eastern jetties to the western dikes. Tidal regimes in Cape Cod Bay and Buzzards Bay are different with the former being tied to the Gulf of Maine and the latter directly to the North Atlantic.

The Bourne and Sagamore Highway Bridges, are fixed spans and have a minimum vertical clearance of 135 feet relative to Mean High Water (MHW). The railroad bridge at Buzzards Bay is a lift bridge, normally kept in the open (raised) position, and also has a minimum vertical clearance of 135 feet MHW. Two overhead power cables also span the Canal land cut with a minimum authorized clearance of 160 feet MHW.

7.2.1 Canal Water Levels and Datum

Before examining future sea states, it is important to understand the present day hydrodynamics of the Cape Cod Canal. The timing and amplitude of high and low water levels in Cape Cod Bay differ from those in Buzzards Bay. High and low tides in Buzzards Bay precede those in Cape Cod Bay by 2.5 to 3 hours. The tidal range in Buzzards Bay averages 3 to 4 feet whereas the tidal range in Cape Cod Bay averages 7 to 8 feet. These differences drive the strong currents which flow through the canal. The tidal datum for each of the Canal crossings are shown in Table 19 relative to Mean Sea Level. As Mean High Water is nearly 1.5 feet greater at the Sagamore Bridge than the Bourne Bridge, the Sagamore Bridge will need to be at a higher elevation relative to NAVD88 than the Bourne Bridge to maintain the same vertical clearance relative to Mean High Water.

Table 19 – Canal Tidal Datum in Feet Relative to Mean Sea Level – NOAA			
Water Level	**Railroad Bridge**	**Bourne Bridge**	**Sagamore Bridge**
Mean Higher High Water (MHHW)	2.18	2.52	3.93
Mean High Water (MHW)	1.81	2.14	3.56
North American Vertical Datum of 1988 (NAVD88)	0.57	0.57	0.56
Mean Sea Level (MSL)	0.00	0.00	0.00
Mean Tide Level (MTL)	0.10	-0.10	-0.17
Mean Low Water (MLW)	-1.60	-2.34	-3.89
Mean Lower Low Water (MLLW)	-1.85	-2.62	-4.20
Mean Range	3.41	4.48	7.45
Great Diurnal Range	4.03	5.14	8.13
Note: Water level datums obtained from NOAA's vDatum			

7.2.2 Sea Level Change

Based on ER 1100-2-8162 and ETL 1100-2-1 (now EP 1100-2-1, 20 June 2019)[1], USACE studies must consider future rates of sea level change that are higher than the historical rates to account for the potential impacts of climate change. Due to the uncertainty associated with future sea level change the USACE policy is to look at three scenarios of sea level change and investigate the impact to project feasibility. These rates are the historic rate at the project site, an intermediate rate and a high rate of sea level rise. The intermediate and high rates are modified from the National Research Council (NRC) curves I and III, respectively. All three local sea level change curves include the global (eustatic) sea level rise rate (approximately 1.7 mm/year according to IPCC 2007) as well as vertical land movement. USACE guidance allows for the consideration of additional curves.

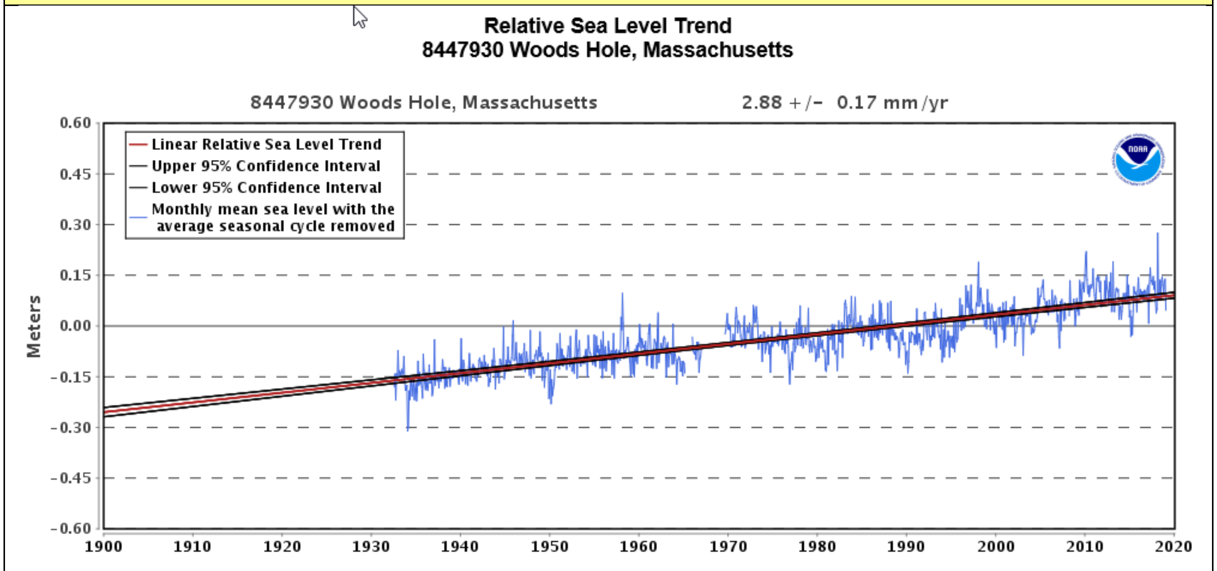
In order to calculate these various rates for a project site, USACE developed an online calculator tool, the Sea-Level Change Curve Calculator (Version 2017.55) (http://corpsmapu.usace.army.mil/rccinfo/slc/slcc_calc.html). The tool uses the nearest NOAA tide station with an adequately long water level record to determine the historical trend. The tool then uses this historical trend along with a formulation provided in the ETL to determine the intermediate and high rates of change. The online calculator can also provide the NOAA sea level change curves.

For the historic mean sea level trend, the Woods Hole, MA NOAA station (NOAA 8447930) was used. The station is 18 miles south of the approximate midpoint between the Canal highway bridges. The Boston, MA NOAA station, located 48 miles northwest of the project area, was also evaluated and only minor differences (0.02 feet over 50 years; 0.03 feet over 100 years) in sea level rise projections were noted between the two stations. Based on this comparison, use of the Woods Hole station alone was considered adequate. The Sea-Level Change Curve Calculator, as a default, uses the historic mean sea level rate published in 2006. However, the user may also select the regional rate (NOAA, 2013) or enter a user-specified rate. The 2006 mean sea level trend at Woods Hole is 0.00856 feet/year or 0.856 feet/century. The regional trend is 0.00876 feet/year or 0.876 feet/century. The NOAA Sea Level Trends web page contains the historic mean sea level rate through 2018. At Woods Hole, this mean sea level trend is 0.00945 feet/year (2.8 mm/year) or 0.945 feet/century based on regionally-corrected mean sea level data from the station's establishment through 2018, 86 years. This long-term linear trend was selected for this analysis and is shown in Figure 15 (https://tidesandcurrents.noaa.gov/sltrends/sltrends_station.shtml?id=8447930). Also shown is the monthly mean sea level without the regular seasonal fluctuations due to coastal ocean temperatures, salinities, winds, atmospheric pressures, and ocean currents. The short term sea level change rate varies due to yearly and decadal cycles.

---

[1] The ETL was replaced by the EP without any change in the guidance. This change occurred while the Canal bridge analysis was underway.

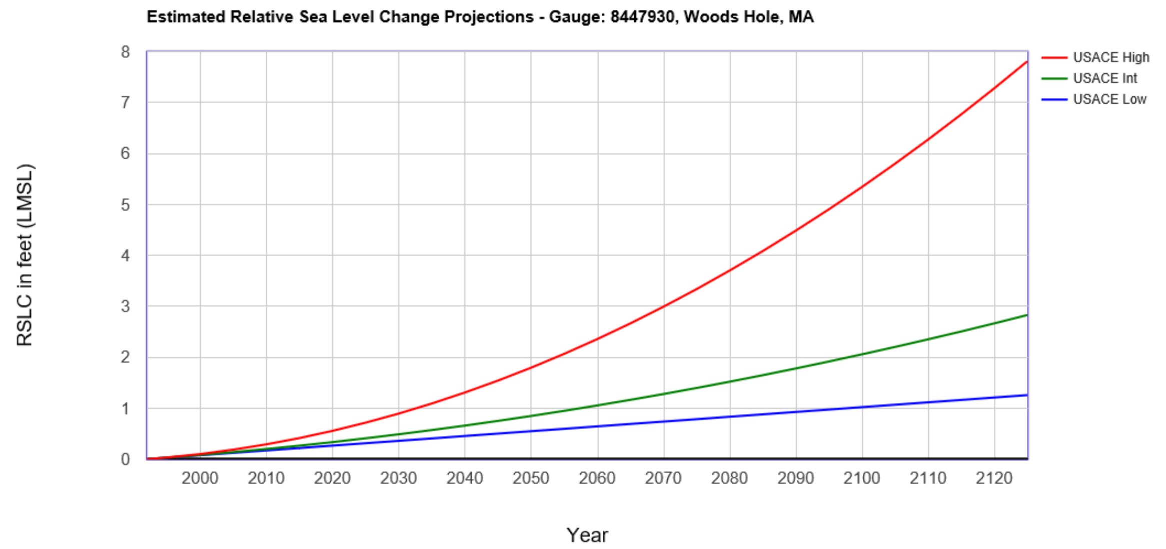
Figure 15 - Relative Sea Level Trend at Woods Hole, Massachusetts – NOAA



(https://tidesandcurrents.noaa.gov/sltrends/sltrends_station.shtml?id=8447930)

The sea level change rates required by USACE for scenario-based sensitivity analysis for future conditions through 2125 are shown in Figure 16 and Table 20. Considering a project start in 2025, the projected sea level changes after 50 and 100 years are highlighted in green in Table 20. Sea level change values are in feet relative to Mean Sea Level established for the present tidal epoch (1983-2001), centered about 1992. As shown the historic rate results in 0.78 feet increase through 2075 while the intermediate and high rates would cause increases of 1.40 feet and 3.34 feet, respectively, within that same period. Looking out 100 years, a rise of 1.26 feet can be anticipated using the historic rate. The intermediate and high rates of sea level change estimate rises of 2.83 feet and 7.82 feet, respectively.

Figure 16 – Relative Sea Level Change Curves - USACE



For reference, the USACE sea level change curves computed using NOAA's 2006 historic sea level change rate and the regional rate are provided at the end of this document, as are the NOAA 2012 and 2017 sea level change curves.

Table 20 – USACE Relative Sea Level Change Predictions

Year	USACE Low	USACE Intermed	USACE High		Year	USACE Low	USACE Intermed	USACE High
1992	0	0	0		2060	0.64	1.05	2.36
1995	0.03	0.03	0.03		2065	0.69	1.16	2.67
2000	0.08	0.08	0.10		2070	0.74	1.28	2.99
2005	0.12	0.14	0.19		2075	0.78	1.40	3.34
2010	0.17	0.20	0.29		2080	0.83	1.52	3.70
2015	0.22	0.26	0.41		2085	0.88	1.65	4.09
2020	0.27	0.33	0.56		2090	0.93	1.78	4.49
2025	0.31	0.41	0.72		2095	0.97	1.92	4.91
2030	0.36	0.49	0.89		2100	1.02	2.06	5.35
2035	0.41	0.57	1.09		2105	1.07	2.20	5.80
2040	0.45	0.66	1.31		2110	1.12	2.35	6.28
2045	0.50	0.75	1.54		2115	1.16	2.51	6.77
2050	0.55	0.85	1.80		2120	1.21	2.67	7.28
2055	0.60	0.95	2.07		2125	1.26	2.83	7.82

NOAA Gage: 8447930 – Woods Hole, MA – User Defined Rate: 0.00945 Feet/Year

All Values are Expressed in Feet Relative to LMSL

This study was conducted to determine whether major rehabilitation or bridge replacement would be the most cost effective, safe and reliable solution to providing vehicular crossings over the Cape Cod Canal. A conservative approach was taken developing a conceptual design for new crossings. This included the bridge type selected, lane widths, approach grades, and sea level rise. The replacement bridge conceptual designs presented therefore include an increased bridge clearance (7.8 feet) to accommodate current vessel traffic at the high rate of sea level rise. Final elevations of the bridges and corresponding air draft clearance will take approach work and adjacent infrastructure into consideration during design phase (Phase II) of the project. This will include a further evaluation of the most appropriate scenario of sea level rise to include in the final design elevation.

Tides in Buzzards Bay and Cape Cod Bay occur on slightly different cycles with different elevations. During the design phase sea level rise and its effect on tidal range and elevations in the Canal with respect to the two tidal regimes will be examined in more detail. If necessary additional bridge height may be required, which would increase the length of the bridges in order to maintain design grades. For the conceptual analysis in this report the sea level change projections used are conservative and significant cost contingencies were used, so a slight increase in deck elevation would not impact that analysis.

7.3 Bourne Bridge Replacement

For the purposes of this concept level design it was assumed that a replacement for the Bourne Bridge would be constructed immediately inshore (east) of the existing bridge. It is believed that this location would minimize alterations needed on connecting roads and other roads in the bridge's vicinity. For NEPA purposes an area of immediate impact extending about 500 feet out in each direction (east and west) from the centerline of the bridge and 1000 feet inland (north and south) from the shore end of each existing abutment was used. A replacement bridge with six vehicle lanes (Plan D) would have a wider deck and impact a larger footprint than the existing bridge with four vehicle lanes.

A new Bourne Bridge of the cable stay type would likely be 19 to 23 spans with a total length of between about 3,500 to 4,000 feet. The estimated length is based on the local topography, required elevation of the superstructure, accounting for sea level rise, and assuming a 4% roadway grade. It is also based on an arbitrary location of the bridge abutments. The bridge would be comprised of precast segmental girders, cables for the cable-stay spans, and three spans of steel multi-girders. There would be two reinforced concrete abutments, 16 to 20 reinforced concrete piers, and two reinforced concrete pylons for the cable-stay span.

7.4 Sagamore Bridge Replacement

For the purposes of this concept level design it was assumed that a replacement for the Sagamore Bridge would be constructed immediately inshore (west) of the existing bridge. It is believe that this location would minimize alterations needed on connecting roads and other roads in the bridge's vicinity. For NEPA purposes an area of immediate impact extending about 500 feet out in each direction (east and west) from the centerline of the bridge and 1000 feet inland (north and south) from the shore end of each existing abutment was used. A replacement bridge with six vehicle lanes (Plan D) would have a wider deck and impact a larger footprint than the existing bridge with its four vehicle lanes.

A new Sagamore Bridge of the cable stay type would likely be approximately 12 to 14 spans with a total length between about 2,400 to 2,900 feet. The length is based on the local topography, required elevation of the superstructure, accounting for sea level rise, and assuming a 4% roadway grade. It is also based on an arbitrary location of the bridge abutments. The bridge would be comprised of precast segmental girders, cables for the cable-stay spans, and three spans of steel multi-girders. There would be two reinforced concrete abutments, nine to eleven reinforced concrete piers, and two reinforced concrete pylons for the cable-stay span.

7.5 Bridge Replacement Costs

The construction cost estimates were developed using Micro-Computer Aided Cost Estimating System (MCACES), Second Generation (MII) using the appropriate Work Breakdown Structure (WBS). The replacement construction cost is based on historical bridge construction estimates for smaller projects scaled up to match the scope of this project. Specific features of work relative the proposed cable-stay bridge type were then added to the estimate. Contingencies were developed using a cost and schedule risk analysis conducted by members of the District's project delivery team. The Risk Analysis utilized the "high risk" category as both the rehabilitation and replacement alternatives represent complex projects involving construction with life safety issues. Assumptions were made to the likelihood and impact of each risk item, as well as the probability of occurrence and magnitude of the impact if it were to occur. Adjustments were made to the analysis upon review by the PDT and the final contingencies were established. Details on the cost estimates and the cost and schedule risk analysis (CSRA) Report are included in the Cost Engineering Appendix.

7.5.1 New Bridge Construction Costs

Table 21 presents the costs for initial construction of replacements for the Bourne and Sagamore Highway Bridges. A new bridge would be built adjacent to and inshore of each existing bridge. The conceptual design used in this phase of analysis was for cable-stay bridges with four through travel lanes plus two auxiliary (acceleration/deceleration) lanes. The new bridges could be built concurrently or over different time periods. Costs for non-Federal improvements to other roadways necessary to tie into the new bridge locations are discussed and presented later.

Table 21
Project Costs – Bridge Replacement Alternatives – Plan D

Cost Category FY 2020 Price Levels ($000s) Revised Feb 2020	Bourne Bridge 4 Lanes plus 2 Auxiliary Lanes	Sagamore Bridge 4 Lanes plus 2 Auxiliary Lanes
Construction Cost	$355,478	$232,630
Contingency %	44%	44%
Contingency Cost	$156,410	$102,357
PED	$40,951	$27,321
Construction Management	$14,199	$9,594
Total Construction	$567,038	$371,902
Cultural Resource Preservation	$29,450	$19,241
Lands, Easements, ROW	$7,645	$7,618
Utility Relocations	$26,640	$29,520
Total Federal Project Cost	$630,773	$428,281
Associated Non-Federal Highway/Roadway Modifications		
State-Funded Bridge Approaches	$90,991	$57,802
Anticipated Future Major Repair Actions for New Bridges (Bourne/Sagamore)		
Major Repairs #1 (2054/2049)	$7,911	$7,906
Major Repairs #2 (None/2069)	- - -	$7,906
Total Project Cost (50 Years)	$729,675	$501,895

7.5.2 Associated State Highway Modifications

Construction of new replacement bridges, no matter how close to the existing bridges, will require modifications to existing surface roads and highways, including those connecting to the bridges on either side of the Canal. The extent and cost of these modifications will depend in part on the final location of the new bridges, the bridge type, and their alignment. Some of the final design factors that will need to be considered include:

- Bridge height over the waterway as a function of navigation clearance required for vessel traffic at high water, the high water datum chosen, and allowance made for future sea level rise will need to be further examined.
- The type of bridge chosen will impact bridge deck elevation (and by extension the landward extent of the abutments), since some bridge types have a greater distance (height) between the deck surface (top of the pavement) and the bottom of the supporting superstructure that ships must be able to pass beneath.
- The approach span grades of the bridge decks on the existing bridges exceed those used in modern highway design. Easing the approach span grades will require moving the new abutments further inshore than the existing abutments. Connections to other roadways would need to be moved inland to accommodate those changes. Federal property boundaries may need to change to accommodate these changes.

The USACE will work closely with MassDOT in defining the scope and cost of state-funded highway and roadway modifications and improvement necessary to connect any new bridges to the regional and local transportation system. The estimates in the table above reflect current coordination and estimates at this Phase I level of analysis. The state has additional improvements under consideration, which while not necessary to accommodate the new bridges or increase traffic capacity, will further improve transportation on and off Cape Cod and around the area of the Canal. The cost of those additional improvements are not part of the overall project cost for the new bridges. The extent of the state highway improvement under consideration, including those needed to support bridge replacement, are shown in Figure 17 below.

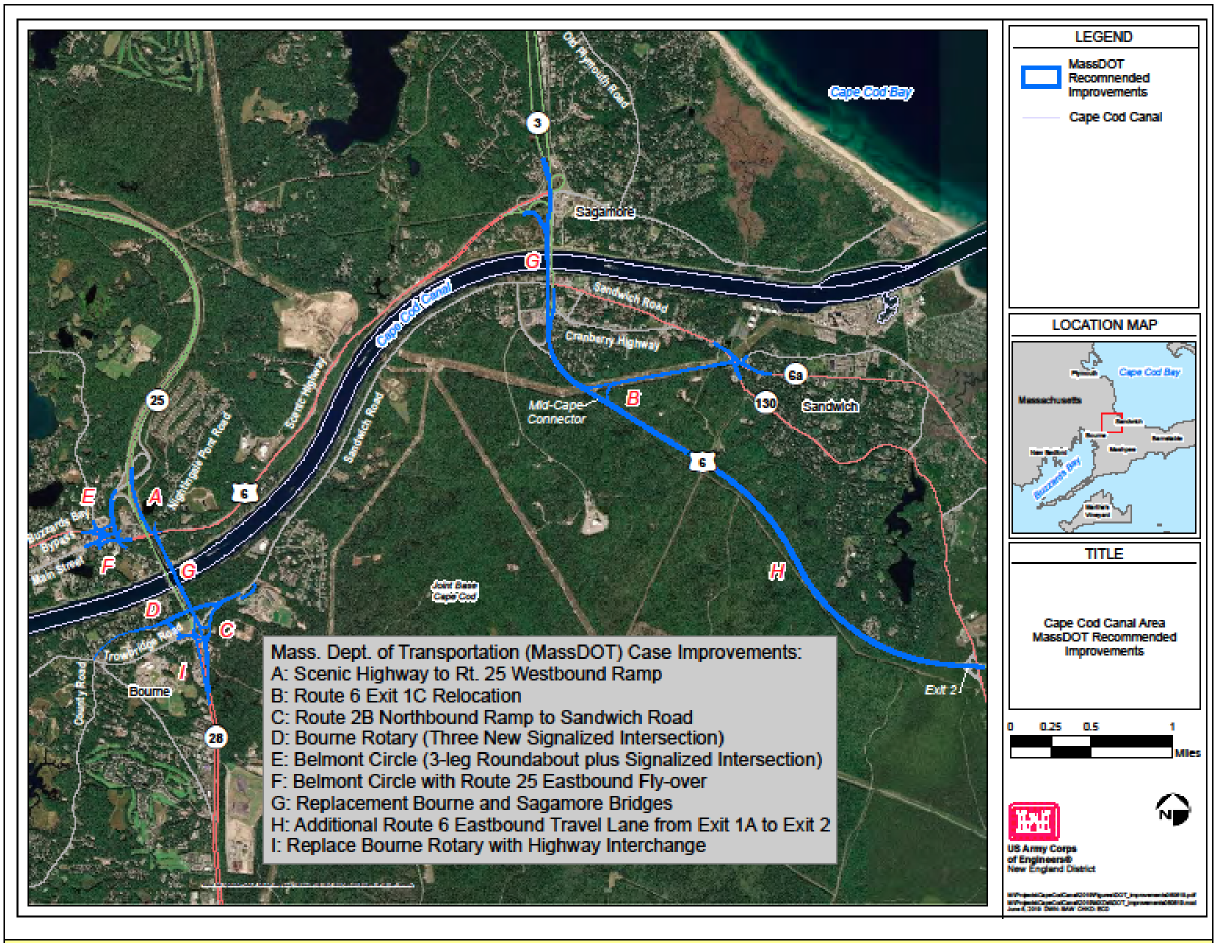

Cape Cod Bay
Old Plymouth Road
3
Sagamore
G
Cape Cod Canal
Sandwich Road
Cranberry Highway
6a
130
Sandwich
B
Mid-Cape Connector
25
Scenic Highway
Sandwich Road
Nightingale Pond Road
6
E
A
Buzzards Bay Bypass
Main Street
F
G
D
C
Joint Base Cape Cod
H
Exit 2
Trowbridge Road
I
Bourne
County Road
28
Mass. Dept. of Transportation (MassDOT) Case Improvements:
A: Scenic Highway to Rt. 25 Westbound Ramp
B: Route 6 Exit 1C Relocation
C: Route 2B Northbound Ramp to Sandwich Road
D: Bourne Rotary (Three New Signalized Intersection)
E: Belmont Circle (3-leg Roundabout plus Signalized Intersection)
F: Belmont Circle with Route 25 Eastbound Fly-over
G: Replacement Bourne and Sagamore Bridges
H: Additional Route 6 Eastbound Travel Lane from Exit 1A to Exit 2
I: Replace Bourne Rotary with Highway Interchange
LEGEND
MassDOT Recommended Improvements
Cape Cod Canal
LOCATION MAP
Plymouth
Cape Cod Bay
Massachusetts
Sandwich
Bourne
Barnstable
New Bedford
Mashpee
Buzzards Bay
Martha's Vineyard
TITLE
Cape Cod Canal Area MassDOT Recommended Improvements
0
0.25
0.5
1
Miles
N
US Army Corps of Engineers®
New England District

Figure 17 – Canal Area State Proposed Highway Improvements

7.5.3 Real Estate Interests and Utility Relocation Costs

Costs for Lands, Easements, Rights of Way, Utility Relocations, and Disposal Areas (LERRD) will be discussed in detail in that later chapter. Real estate interests would be required for bridge replacement alternatives. A project of this magnitude could be expected to require a comprehensive and diverse package of standard and non-standard estates including fee acquisitions, permanent easements, construction access agreements, relocation costs, and other real property interests. Both major rehabilitation and bridge replacement would require utility relocations as well as new and amended easements and licenses for utilities to cross Federal lands. The detailed design phase of this effort would determine the extent and nature of the required interests.

7.6 Traffic Management during Bridge Replacement

Traffic management, both vehicular and marine would be required during any bridge replacement project. Both bridges would have similar impacts.

7.6.1 Vehicular Traffic Management during Bridge Replacement

Some level of land-side vehicular traffic management would be required during bridge replacement, but would not be as extensive or disruptive as a major rehabilitation project. These impacts have not been quantified as design details await the next phase of the project. With the existing bridges remaining open to traffic during construction of the new bridges, traffic across the Canal would be mostly similar to the existing condition. Closures of the existing bridges during this period would only be for emergency repairs. Deliveries of equipment and materials, especially delivery of large pre-fabricated sections of the new bridges, may disrupt traffic and cause delays for limited periods. This could be mitigated in part by scheduling such deliveries for non-peak traffic times.

The reconfiguration of connecting highways and approach roads would have a greater impact on vehicular traffic during the later stages of each replacement. As surface roads are relocated or otherwise modified, traffic patterns will need to be periodically adjusted to facilitate construction. Specific analysis of traffic patterns and control requirements would be evaluated during detailed design phase as final bridge types, construction methods, and timelines are determined.

7.6.2 Marine Traffic Management during Bridge Replacement

Impacts to marine traffic management during bridge replacement will depend largely on the type of bridge being built, which would determine what level of construction activities would occur from the land versus the water. Large precast or preassembled sections of the bridge center spans may need to be assembled, positioned, lifted and placed from barges in the Canal channel and could pose a hazard to navigation of the Canal or require closures of the Canal to marine traffic for periods of time. Similarly, demolition of the existing bridges (center span superstructure and in-water piers) would likely be accomplished at least in part using waterborne equipment (barges and cranes) that may conflict with marine traffic and require closure of the Canal for periods of time.

It was assumed for this study that there would be at least 30 days where marine traffic through the Canal would be delayed or prohibited due to construction of each new bridge and demolition of the existing bridge. A more specific number of delay days would be determined during the detailed design phase.

7.7 Future Operation, Maintenance and Repair Costs for Replacement Bridges

The costs for new bridges must also account for costs over the 50-year economic life. The new bridges will have annual costs for operation, maintenance. They will also have costs for repairs, including major repair actions during that period. At this time estimates of cost and timelines for even major repairs are highly speculative given the conceptual level of the replacement design. However a major repair action near the end of the new bridges' economic life period has been estimated and is included in Table 21 above, and two such repair actions were included for the Sagamore Bridge due to its heavier traffic load.

8.0 ECONOMIC ANALYSIS

As part of the MRER, an economic evaluation was preformed to analyze the costs and benefits of the "without project" condition and compare it to alternatives. The "without project" condition refers to a baseline of continued regular inspections and standard maintenance on the bridges as the need arises; a fix-as-fails scenario. Below is a brief summary of the findings of the economic analysis. For further information please refer to Appendix D: Economics.

The economic study area consists of the regions occupied by the two bridges, their approaches, and nearby sections of the connecting highways within which traffic is impacted by the deterioration of the two ageing 85-year old bridges. For the Sagamore Bridge that area extends between Route 3 Exit 2 (Herring Pond Road) in Plymouth, south to Route 6 Exit 2 (Route 130, Forestdale Road) in Sandwich. For the Bourne Bridge that area extends between Route 25 Exit 2 (Glen Charlie Road) in Wareham and Route 151 in Mashpee.

8.1 Federal Interest

The authority for the Cape Cod Canal FNP includes the authority to operate and maintain two highways bridges connecting the areas of the two communities bisected by the Canal. The language in Section 1315 of the America's Water Infrastructure Act of 2018 provides further authority for replacement of the highway bridges. The purpose of the MRER is to determine the most economical means of providing safe, efficient, and reliable access over the Canal by vehicular traffic. The purpose of this analysis is to evaluate and compare the costs and benefits of the various alternative measures and recommend the most economically justifiable solution, consistent with protecting the nation's environment. Improving safety and reliability also requires an examination of alternatives to the base condition of continued maintenance and repair, and the major rehabilitation of the two bridges.

8.2 Overview of Economic Analysis Methodology

The basic criteria for an economically viable project are that the present value of the benefits exceeds the present value of the costs, and/or that the rate of return on the investment exceeds the cost of capital. The benefits represent the incremental economic payoff of the project. The costs are opportunity costs. That is, the value of the foregone alternative investment. The Federal Discount Rate, based on the rate of return on risk-free Treasury securities and currently set at 2.75 percent for Fiscal Year 2020, is used to discount the scenarios.

For this analysis the federal government's expenditures to operate, maintain, repair, and rehabilitate the existing bridges, or to build replacement bridges represents the cost. The costs of project design, real estate interests, utility relocations, environmental mitigation, and work by others to modify state and local roads as needed to facilitate the USACE work are also included in total project costs. The benefits of the project refer to the quantifiable, incremental gains that accrue to the society as a result of the project (the "with-project" condition), as compared to the base condition of maintaining the bridges as needed (the "without-project" condition).

8.2.1 Economic Methodology

Economic analysis is performed using a risk based approach to compare costs and benefits of each alternative to the without project (base) condition. Reliability functions from engineering event trees are utilized to simulate the life cycle of components, possible component failures and associated repair costs. The three engineering components that could experience failure are the bridge deck, substructure, and superstructure. This analysis is evaluated over a 50-year period using a Monte Carlo Simulation to determine long-term costs of the future base condition without-project and the future with alternatives. The model has been approved for single-use by the USACE Planning Center of Expertise for Inland Navigation and Risk Informed Economics Division.

The cost of each alternative includes the cost of the repair itself, the economic cost to vessels that cannot use the canal (navigation costs), operation & maintenance costs, and the change in value of time incurred by drivers in traffic delays (travel costs) during lane closures for repairs or construction. This traffic data and forecasts were used to determine the total hours of traffic delay incurred during construction for all travelers crossing the bridges. A monetary value was attributed to these lost productive hours using the average hourly household median income of the surrounding towns as sourced from the US Census Bureau.

Traffic disruptions associated with construction activities may cause some visitors to choose an alternate travel destination away from Cape Cod. There would be a substitution effect as these vacationers may decide to travel to other areas such as Maine or New Hampshire. This impact is expected to be minimal as construction activities for the proposed alternatives will scheduled to avoid peak visitor travel times in the summer and on holidays. Travelers driving to the Cape for work or non-vacation reasons will still need to commute over the bridges because they provide the only access on and off Cape Cod. The economic analysis does not reflect the possible substitution effect of visitor volume. The current analysis provides a more conservative estimate in the case of the alternatives. If visitor traffic were to decline as a result of project construction, traffic flows would actually improve for the non-visitors and in turn reduce the value of time cost of the project. Therefore, the final decision will not change due to this assumption.

For the bridges the additional costs due to component failures are discounted in the year of failure. For each iteration of the model these costs are summed over the project life. The model is iterated 100,000 times each year over the fifty years and the average annual costs are obtained by summing the costs over the fifty years and annualizing using the capital recovery factor of 0.03704 based on the 2-3/4% Fiscal Year 2020 discount rate.

Benefits are reductions in repair and maintenance costs and travel delay costs between the proposed alternatives and the base condition. Each alternative is evaluated against the base case. Each alternative and the base case have separate sets of hazard indices for each system component. The hazard rates increase over time reflecting the increased probability of failure due to deteriorating conditions.

8.2.2 Discounting and Period of Analysis

For most transportation investments, costs are incurred in the initial years, while the benefits from the investment accrue over many years into the future. When assessing the costs and benefits of a project, it is necessary to take into account the time value of money by converting the costs and benefits that take place in different years into a common year. This discounting converts future costs and benefits that occur in different years into a value for a common year (present value). The base year of the analysis is 2020. The USACE requires a 50-year period of analysis for evaluating Federal navigation project investments. The analysis will cover the 50-year period from 2020 – 2069. This period is different from that used for the structural engineering reliability analysis which was completed in 2016 and was based on specific temporal data points for the condition ratings of the bridges.

The year 2020 was selected as the base year because the decision on the recommended plan contained within the MRER is expected to be made in 2020. Base year dollars are valued in dollars that are directly comparable to the current dollars for a given year. The base year can be adjusted by multiplying costs and benefits by the respective rate. Ultimately, how the alternatives compare will not change and therefore, adjusting the base year does not impact the final decision made within the report.

8.3 Base Condition – Alternative A – Fix-as-Fails

Under the without-project (base) condition no improvements are made and the bridges will be operated, maintained and repaired as the need arises. Bridge components will be fixed as failure occurs. It is anticipated that service disruptions will continue and bridge use will eventually be weight limited. This is the base condition that will be compared to the proposed alternatives of rehabilitation and construction of new replacement bridges. The net benefits are calculated by taking the difference between the without- and with-project conditions. A benefit-cost ratio greater than one indicates that the project's net benefits outweigh the costs.

The overall condition of both the Bourne and Sagamore Bridges is becoming worse as the bridges age and major maintenance projects becomes more frequent. As conditions deteriorate the bridges become structurally deficient. Both bridges are functionally obsolete and are routinely unable to provide an efficient flow of traffic in conjunction with the State and local roadway network leading to the bridge approaches. As discussed in Appendix A – Engineering Reliability Analysis, the Bourne Bridge is structurally deficient and both bridges are functionally obsolete.

The future without-project condition outlines the condition in which there is no major rehabilitation or replacement of the existing bridges. It is assumed that continual, regularly-scheduled maintenance will be performed on the existing structures and emergency funds will be provided in the event of performance failure. Travel delays due to lane or bridge closures are expected during necessary maintenance and repair projects. The cost of these repairs, plus the cost of traffic delays, together represent the cost of this alternative.

8.3.1 Probability of Unsatisfactory Performance – Base Condition

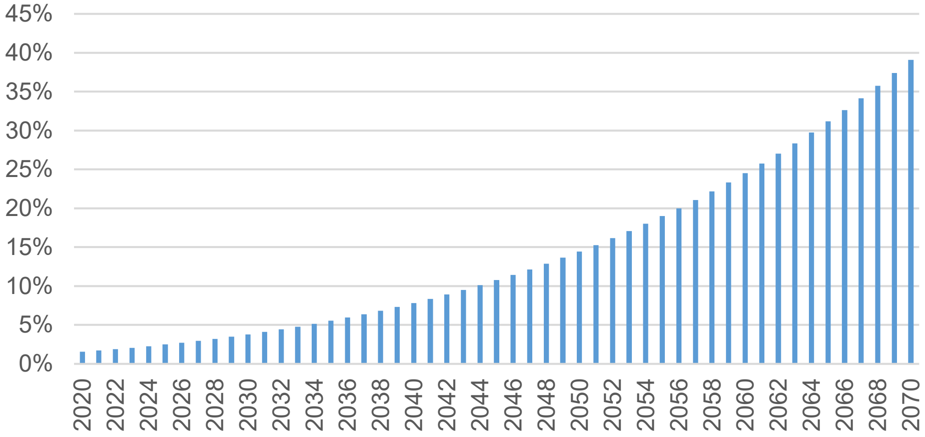
Probability of unsatisfactory performance (PUP) functions exhibit instantaneous probabilities of major bridge components, the superstructure, substructure, and deck, not performing as designed. PUP functions as applied to the bridges are related to age, and must also have measurable consequences. The PUP functions are determined during engineering reliability analysis through expert elicitation. Unsatisfactory performance in this study is defined as the physical condition of the bridges' critical elements being assigned a Condition Rating of 4 (Poor) or less (see the FHWA NBIS ratings discussion in Chapter 4). For a more detailed description of the consequences of unsatisfactory performance please refer to Appendix A – Engineering Reliability Analysis. In the figure below are example charts depicting probability of unsatisfactory or failure curves of the three bridge components for the base condition.

8.3.2 Probabilistic Analysis – Base Condition

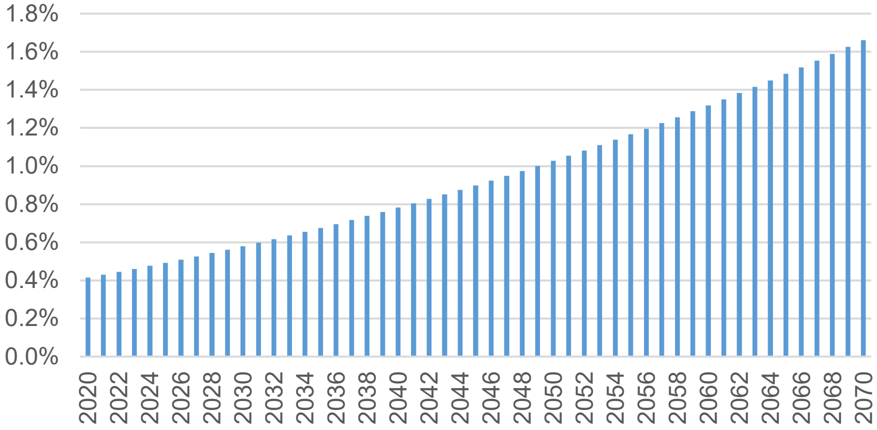
Engineering reliability must be integrated with economic costs to ensure that impacts related to all possible consequences are accurate for final cost-benefit analysis. Event trees are the primary tool used to identify and estimate risk and were designed to predict individual component performance. Event trees were created for each bridge, as well as for each engineering component, and were modeled using Palisade PrecisionTree software. A progression of events begins with an initiating event and continues through a set of outcomes with probabilities and consequences assigned to each possible outcome. The three bridge components were further evaluated for failures that could trigger major or catastrophic rehabilitation or replacement costs. The failures are defined as deterioration of the bridge deck, substructure, and superstructure resulting in a condition rating of 4 or lower. Probabilities of localized or widespread deterioration of each were created through engineering reliability analysis. Actions to restore performance from each scenario are also evaluated. Costs of these repair or replacement scenarios (from Table 14) are included in the event tree.

Figure 18 – Probability of Failure – Base Condition – Existing Bridges

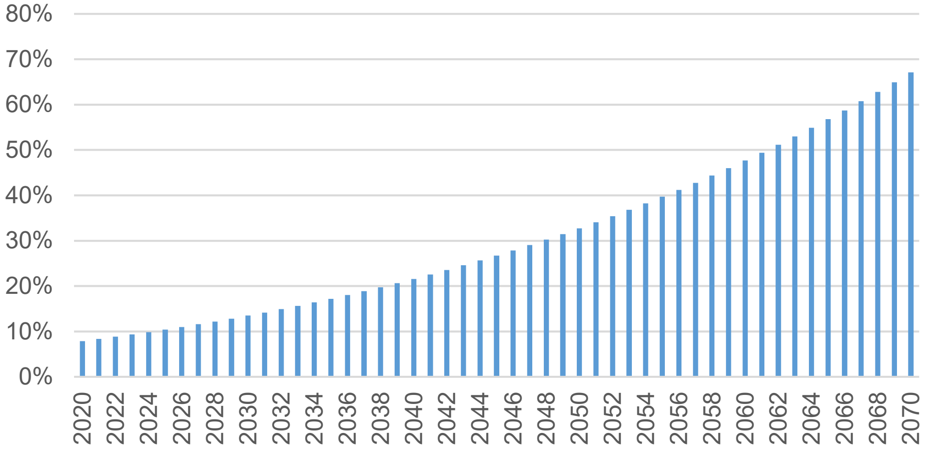
Probability of a Bridge Deck Failure



Probability of Substructure Failure



Probability of Superstructure Failure



For each construction scenario there are traffic delays due to lane or bridge closures. Costs for closures were calculated and incorporated into the event tree. The resulting total cost of each event includes the rehabilitation cost and travel delay costs, as shown in Table 22. Please see Appendix D - Economics for further discussion of event trees.

Table 22 – Base Condition – Repair and Traffic Delay Costs ($000)

Component and Failure Description	**Cost to Repair**		**Traffic Impact**	**Traffic Cost in 2020**	
	Sagamore Bridge	**Bourne Bridge**		**Sagamore Bridge**	**Bourne Bridge**
Superstructure					
Advanced deterioration of secondary member, non-critical Gusset Plate, Stringer, Floorbeam, or Hanger Cable	$6,600	$6,200	9 months lane closure - no closures Memorial Day to Columbus Day	$32,700	$21,100
Advanced deterioration of Main Truss Member or Critical Gusset Plate	$15,300	$20,200	18 months lane closures, divert trucks over 16 ton to sister bridge for 12 months	$321,200	$186,200
Catastrophic Damage to Main Truss Member or Critical Gusset Plate	$310,300	$547,700	60 months bridge Closure	$10,343,400	$4,584,000
Bridge Deck					
Localized deterioration of Roadway Joint(s), Granite Curbs, Concrete-filled Steel Grid over Bridge Spans, or Reinforced Concrete Deck at Abutments	$5,100	$5,800	6 months of temporary lane closures, no closures Memorial Day to Columbus Day	$21,800	$14,100
Widespread Deterioration of Concrete-filled Steel Grid Deck over Bridge Spans and Reinforced Concrete Deck at the Abutments	$5,900	$7,600	15 months of temporary lane closures, no closures Memorial Day to Columbus Day	$54,400	$35,200

Table 22 – Base Condition (Continued) – Repair and Traffic Delay Costs ($000)

Substructure					
Localized Concrete Defects such as Cracks or Spalls on Vertical Surfaces of Piers or Degradation of Concrete under Bearings on the Piers	$400	$500	6 months of lane closures, no closures Memorial Day to Columbus Day, lane closures limited to non-peak hours, weekdays	$18,300	$13,400
Widespread Concrete Defects such as Cracks or Spalls on Vertical Surfaces of Piers or Degradation on Concrete under Bearings on the Piers	$700	$1,100	12 months of lane closures, no closures Memorial Day to Columbus Day, Lane Closures limited to non-peak hours, weekdays	$36,600	$26,700
Source: Economics Appendix D – Table D-7					

8.3.3 Traffic Data Collection and Analysis – Base Condition

The Sagamore and Bourne Bridges provide the only vehicular access to Cape Cod. Therefore traffic restrictions during construction projects will likely disrupt the local economy. Lane or total bridge closures are required in the event of emergency maintenance after a component failure. Commuters and travelers over the bridges will experience a loss of time due to traffic delays.

MassDOT is conducting a transportation study to examine current traffic conditions in the area surrounding the Sagamore and Bourne Bridges. The USACE worked with a contractor, TrafInfo, to collect this data for existing traffic conditions (2014) and future conditions (2040), and design a regional travel demand model. The model simulates traffic volumes at various times of the day in the existing and future conditions with partial lane closures and full bridge closures. Please see Appendix D - Economics for further discussion of traffic analysis.

8.3.4 Impacts to Navigation – Base Condition

The Canal is a key transportation link for vessel traffic transiting the US east coast, between southern New England, New York, or points south, and Boston, northern New England, and points north. Without the Canal, vessels would have to transit around the arm of Cape Cod. Deeper draft vessels would also need to travel around Martha's Vineyard, Nantucket and the shallow banks farther east. This would increase vessel travel distances by at least 60 nautical miles, an 18 percent increase for vessels traveling between New York and Boston. Each year the Canal is used by more than 3,000 cargo vessels, at least 750 fishing vessels, 150 – 200 military vessels, and more than 4,000 recreational vessels, all of which benefit greatly from the shorter and safer travel route. Since its completion in 1914, the Canal has increased the efficiency of waterborne commerce shipments in the Northeast, contributing greatly to the national economy. The Canal also increases navigation safety. Prior to construction of the Canal, many shipwrecks occurred along the route around the Cape, since fog, shoals and exposure to bad weather are significantly worse in the areas off Cape Cod compared to the interior. The navigation benefits provided by the Canal are extremely important to the economies of Massachusetts, New Hampshire, and Maine, with critical shipments of petroleum products making up the majority of cargo traffic through the Canal, and with vessels of all types benefiting from the shorter and safer transit route.

Temporary closure of the Canal would occur under certain bridge component failure scenarios, forcing navigation traffic to use the longer outer route through the North Atlantic. There are three instances when a component failure will require closure of the canal for navigation – a catastrophic bridge failure (30 day closure); localized concrete defects such as cracks or spalls on vertical surfaces of piers or degradation of concrete under bearings on piers (2 weeks); and widespread concrete defects such as cracks or spalls on vertical surfaces of piers or degradation of concrete under bearings on piers (4 weeks). These instances are only likely to occur a few times over the 50-year period of analysis. The total annual cost is the mean sum over that period then annualized. This cost to navigation is comparatively low as estimated in Table 23 below.

8.3.5 Annual Maintenance Costs – Base Condition

In addition to the costs associated with emergency repairs, there are annual maintenance costs to upkeep the bridges each year. Currently, average annual maintenance costs are $411,000 (in 2020 dollars) for the Sagamore Bridge and $295,000 for the Bourne Bridge. In the event tree scenario in which there is catastrophic failure in the superstructure, the result is immediate closure of the bridge with the design and construction of a replacement bridge. Annual maintenance for replacement bridges will cost $38,000 each (Appendix D, Sec 4.5).

The repair and maintenance costs as well as the value of time due to traffic and navigation costs were used as inputs for the Monte Carlo Simulation. The Monte Carlo Simulation was run with 100,000 iterations. In the Base Condition, continual maintenance is performed on the existing structures and emergency funds are provided in the event of performance failure. As the bridges continue to age over time their condition will deteriorate and emergency funds will be needed more frequently. Table 22 below summarize the annual cost results for the Base Condition for each bridge.

The travel costs are substantially higher for the Sagamore Bridge when compared to the Bourne Bridge. This is due to the fact that a lane or bridge closure on the Sagamore would strain the infrastructure around the Bourne Bridge, particularly at the Bourne Rotary, causing extensive time delays for travelers waiting in traffic.

Table 23 – Annual Costs – Base Condition ($000s) Updated Feb-March 2020 – See Appendix D, Table D-66					
FY2020 Price Level	**Repair Cost**	**Travel Cost**	**Navigation Cost**	**O&M Cost**	**Total**
Sagamore Bridge					
Mean	2,800	120,700	1	400	123,900
Bourne Bridge					
Mean	3,200	61,700	1	300	65,200

8.3.6 Summary of Future Without-Project Condition – Base Condition

The base case condition stipulates that the bridges be maintained but their aging condition will continue to deteriorate over the 50-year study. The bridges will become increasingly unreliable resulting in higher occurrences of expensive emergency repairs. Impacts to travelers will be associated with the repairs. The total annual cost of operating the Sagamore and Bourne Bridges over 50 years is an estimated $189.1 million ($123.9 + 65.2 million) of which $6.0 million ($2.8 + $3.2 million) are annual direct emergency repair costs for component failures. Navigation costs are $0.7 million per bridge.

8.4 Alternative B – Major Rehabilitation

Major rehabilitation of both the Sagamore and Bourne bridges would avoid most of the emergency repair costs of a potential failure because the rehabilitated bridges will have improved reliability functions, meaning that the probability of component failure will decrease. As described earlier in Chapter 5 the rehabilitation alternative (Plan B) would include the following work:

- Truss Span Deck Replacement
- Stringer Replacement/Repair
- Floorbeam Replacement/Repair
- Suspender Cable Replacement
- Abutment Span T-Beam Rehabilitation
- Abutment Span Deck Rehabilitation
- Bearing Repairs
- Joint Replacement
- Steel Truss Repairs
- Paving (Overlay)
- Painting of Structural Steel

The recommended timeline for the major rehabilitation is 2025 through 2027 for the Sagamore Bridge and 2029 to 2031 for the Bourne Bridge. For more details on the major rehabilitation project see Appendix A – Engineering Reliability Analysis.

The Major Rehabilitation project will improve the reliability of bridge components and therefore decrease the probability of unsatisfactory performance. Benefits represent a reduction in emergency repair costs following a component failure and associated time value costs from lane closures related to these repairs. Modeling these phenomena provided a method to quantify the net benefits for current and future users.

8.4.1 Probability of Unsatisfactory Performance – Major Rehabilitation

The Major Rehabilitation project would result in more reliable bridges with significantly smaller probabilities of future component failures. The analysis is similar to that conducted for the Base Condition as described in Section 8.3 above. Provided in Figure 19 below as an example are probability of unsatisfactory performance charts for the superstructures of both bridges, exemplifying improved reliability functions under Major Rehabilitation.

As depicted in the figure above, the probability of a failure for any type of superstructure will be reduced to 0.3% following the major rehabilitation to be in line with the failure rate in 1981, the historical last major rehabilitation project. The probability of failure will rise throughout the forecast horizon before being adjusted back to 0.3% in the second scheduled major repair project. Failure rates will remain below 8% following the major rehabilitation in both the Sagamore and Bourne Bridges, compared to 64.9% in the final year of the base condition. The probability failure chart for the bridge decks is similar to that of the superstructure. The chart for the substructure rises in a more uniform curve from 0.4% in 2020 to almost 1.7% in 2070.

Following the major rehabilitation, the event trees used to predict the severity of a component failure will be different than in the base condition. The major rehabilitation will hinder the occurrence of more severe component failures. Please see the Appendix D – Economics, for the full detailed analysis of all three bridge components.

Figure 19 - Probability of Unsatisfactory Performance
Sagamore and Bourne Bridges - Superstructure

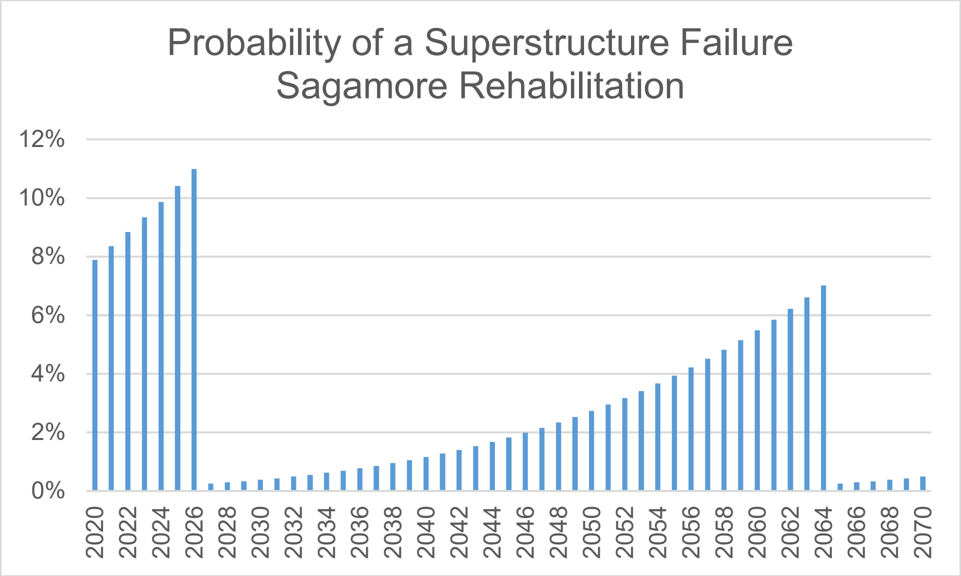
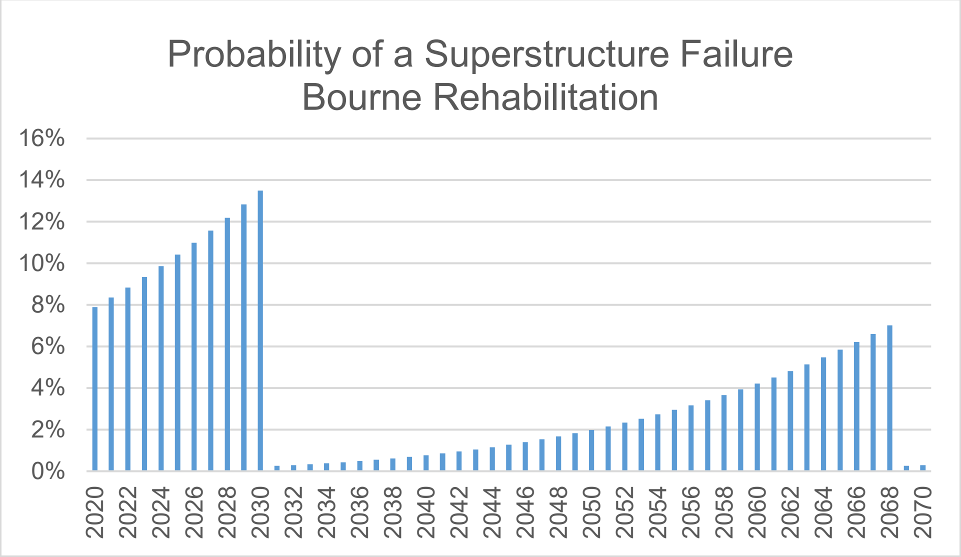


Figure 19 (Continued) - Probability of Unsatisfactory Performance



8.4.2 Results of Monte Carlo Simulation – Major Rehabilitation

The repair, navigation, and travel costs are determined using Monte Carlo Simulation. After each unscheduled failure, there is an associated emergency repair cost, possible navigation cost, and travel delay costs. These costs are consistent with those for the Base Condition because the bridges are structurally the same and repairs will be the same before and after Major Rehabilitation. Failure frequency will decline, and the severity of the failures will also decrease after rehabilitation. The O&M costs will remain the same for the rehabilitation alternative.

The Monte Carlo Simulation was done over the 50-year period for the Major Rehabilitation alternative with 100,000 iterations. Please see Appendix D – Economics for further discussion of the Monte Carlo Simulation. The benefit of Major Rehabilitation is a total cost savings of $115.1 million annually for the Sagamore Bridge and $59.1 million annually for the Bourne Bridge, as shown in the table below.

Table 24 – Annual Cost & Benefits – Major Rehabilitation

Annual Costs ($000) FY2020 Price Levels (Updated March 2020)	Discounted Cost (2020)		Annual Benefit
	Base Condition	Major Rehabilitation	
Sagamore Bridge - Benefits			
Mean	123,900	8,800	115,100
Bourne Bridge - Benefits			
Mean	65,200	6,100	59,100
Note: Data from Economics Appendix D – Table D-68			

8.4.3 Cost of Major Rehabilitation

The cost of the major rehabilitation comprises the total construction cost of the major rehabilitation and the time-value cost of the lane and bridge closures associated with the major rehabilitation construction. The components of Major Rehabilitation were described in detail in Chapter 5 and Appendix A. The recommended timeline for the major rehabilitation is 2025 through 2027 for the Sagamore Bridge and 2029 to 2031 for the Bourne Bridge.

The majority of costs for the Major Rehabilitation alternative would be incurred at the beginning of the construction timeline. The construction cost (FY2020) for Major Rehabilitation for the Sagamore Bridge is $300.7 million, and $345.1 million for the Bourne Bridge. Over the 50 years following Rehabilitation the bridges will again begin to deteriorate resulting in necessary future action to prevent component failures. That work would be in two categories (1) major repairs and the third rehabilitation action, and (2) maintenance and minor repairs (see Table 17). In the first category each bridge will need to undergo two major repair projects that are fairly extensive and not considered to be regular annual maintenance repairs. The first would be a major cleaning, repair, and repainting of the structural steel components. The second would be the bridges' third major rehabilitation action in their project life cycle. Table 25 summarizes the costs for the major rehabilitation, subsequent major repairs, and the years in which they would occur.

There are additional scheduled repairs referenced in Appendix C: Cost Engineering that include maintenance painting, joint replacement, and paving. Those out-year projects are considered part of annual operation and maintenance (O&M) for the purpose of the economic analysis.

Table 25 – Major Rehabilitation Design and Construction Costs

Project Costs in $000s FY2020 Price Levels (Updated Feb 2020)	**Sagamore Bridge Construction Cost**		**Bourne Bridge Construction Cost**	
	Years	**Cost**	**Years**	**Cost**
Major Rehab	2025-2027	$156,301	2029-2031	$186,171
Complete Painting	2045	$33.425	2049	$26,827
Truss Deck Replacement, Floor Beam Repair, Complete Painting	2065	$110,940	2069	$132,120
Total Rehab Cost		$300,666		$345,118

The expected lane closure requirements for the Major Rehabilitation alternative were discussed in Section 5.3. Lane and bridge closures will not occur Memorial Day through Columbus Day to avoid impacting the busy tourist travel seasons as well as Patriots Day and Thanksgiving weekends. For logistical purposes, construction will also be limited during the winter months as construction is made far more difficult under cold winter weather conditions. Lane closures with Major Rehabilitation were estimated to be a total of 480 days for the Bourne Bridge and 380 days for the Sagamore Bridge. Full bridge closures were estimated at 180 days for the Bourne and 130 days for the Sagamore. Lane and bridge closures will negatively impact commuters and vacationers traveling over the bridges. Table 26 displays the actions and associated travel costs for Major Rehabilitation during the 50-year study period for each bridge.

Table 26 – Rehabilitation Construction and Travel Costs ($000s)
(Updated Feb-March 2020)

Years	Construction Cost	Travel Cost	Total Cost
Sagamore Bridge Rehabilitation Construction and Travel Costs			
2025-2027	$156,300	$661,800	$818,100
2045	33,400	124,000	157,400
2065	110,900	495,200	606,100
Total	$300,700	$1,281,000	$1,581,700
Bourne Bridge Rehabilitation Construction and Travel Costs			
2029-2031	$186,200	$530,100	$716,300
2049	26,800	87,000	113,800
2069	132,100	331,200	463,300
Total	$345,100	$948,400	$1,293,500
Note: Costs are FY2020 Price Levels and are discounted in final analysis			

8.4.4 Annual Cost of Major Rehabilitation

Traffic delays on the Sagamore Bridge amounted to 510 days of disrupted traffic at an additional economic cost of $1.3 billion. Traffic delays on the Bourne Bridge amounted to 660 days of disrupted traffic for an additional cost of $948 million. The total cost of the rehabilitation will be $35.9 million annually for the Sagamore Bridge and $27.1 million annually for the Bourne Bridge. The impact of traffic delays is a major component in adding costs, highlighting the importance of these structures in traffic flows. Annualized costs for the Major rehabilitation of each bridge are shown in the table below.

Table 27 – Major Rehabilitation – Total Annualized Costs		
FY2020 Cost ($000) – March 2020	**Bourne Bridge**	**Sagamore Bridge**
Construction Cost of Rehabilitation – 2025 through 2031	$186,200	$156,300
Construction Cost of Additional Rehab Work –2045 through 2069	158,900	144,400
Travel Delay Costs	948,400	1,281,300
Total Costs (FY 2020 Dollars)	$1,293,500	$1,582,000
Discount Factor	2.75%	2.75%
Capital Recovery Factor	0.03704	0.03704
Discounted Cost of Rehabilitation	$142,000	$132,900
Discounted Additional Rehab Work	47,200	49,700
Discounted Travel Delay Cost	536,700	782,600
Interest During Construction (IDC)	5,200	4,300
Total Discounted Cost	$731,100	$969,500
Annualized Cost	$27,100	$35,900

Interest during construction (IDC) is the interest cost incurred while the disbursement of payments is distributed over the course of the project construction, as costs do not hit in one year but rather is assumed over the duration of the construction period. The time period for the IDC calculation was 3 years for Major Rehabilitation

8.4.5 Major Rehabilitation – Results of Economic Analysis

The benefits of Major Rehabilitation are the quantifiable, incremental gains that will accrue to the society as a result of rehabilitation ("with-project" condition), as compared to the current Base Condition ("without-project" condition). The total benefits from decreased emergency repairs following component failures in the Base Condition are compared to the total cost of the major rehabilitation which includes both construction costs and value of time costs from traffic delays. A benefit-cost ratio (BCR) greater than one indicates that the project's benefits outweigh the costs. As shown in the table below, both bridge rehabilitation projects result in net benefits and benefit-cost-ratios greater than 1. Please see Appendix D, Economics, for further discussion of analysis of each bridge.

8.4.6 Summary of the Major Rehabilitation Alternative

The economic analysis supports the Major Rehabilitation projects for both bridges over maintaining the bridges in the "fix-as-fails" Base Condition. As shown in the table below both rehabilitation projects result in net benefits and benefit-cost-ratios greater than 1. The impact of traffic delays is a major cost component highlighting the importance of these structures in traffic flows.

Table 28 – Annual Major Rehabilitation Costs and BCR						
FY 2020 ($000)	**Discounted Cost**		**Annual Benefit (Difference)**	**Annual Cost**	**Net Annual Benefit**	**Benefit Cost Ratio**
	Base Condition	**Major Rehabilitation**				
Sagamore Bridge Rehabilitation Costs and BCR						
Mean	123,900	8,800	115,100	35,900	79,200	3.2
Bourne Bridge Rehabilitation Costs and BCR						
Mean	65,200	6,100	59,100	27,100	32,000	2.2
Source: Base Case (Emergency Repairs) and Major Rehabilitation discounted (2020) costs come from the Economic Appendix D, March 2020 Update, Tables D-68 through D-70. Annual Benefits are the difference between the Base Case and Major Rehabilitation costs. BCRs are from Appendix D, Table D-71.						

8.5 Alternative D – Replacement with 4 Lanes and 2 Auxiliary On/Off Lanes

The Bridge Replacement alternative, Plan D, involves construction of new bridges adjacent to each of the two existing bridges, with two auxiliary acceleration/ deceleration lanes (one in each direction), in addition to the 4 through travel lanes. This is an alternative to the Base Condition and Major Rehabilitation. This scenario has a greater upfront cost but also allows for a more reliable bridge structure that meets current FHWA and MassDOT standards and guidelines for highway and bridge design. The proposed bridge(s) would include one auxiliary lane on both sides (6 lanes total) to meet the needs of traffic safety and alleviate traffic congestion by separating entering and exiting traffic from through traffic. The new bridges would also include a wider sidewalk for pedestrian and bicycle traffic. The existing bridges will remain in service until the new bridges are opened to traffic. The new bridges would not require lane and bridge closures during their construction. There would be minor traffic impacts and travel delays during construction of the approach modifications by the state. The new bridges would not require extended lane and bridge closures and would have a lower maintenance cost when compared to the current bridges, however construction costs are higher than the costs of rehabilitation. The recommended timeline for the construction of the new bridges is 2025 through 2029 for the Sagamore Bridge and 2030 to 2034 for the Bourne Bridge.

Replacement of the bridges will improve the reliability of bridge components and therefore significantly decrease the probability of failure. In this situation, failure is defined as unsatisfactory conditions that would require limiting the weight (load-posting) allowed to be carried over the bridges. Benefits represent a reduction in emergency repair costs following a component failure and associated time value costs from lane closures related to these repairs. In addition, the new bridges will also have lower annual maintenance costs throughout the 50-year forecast. Modeling these phenomena provided a method to quantify the net benefits for current and future users.

8.5.1 Probability of Unsatisfactory Performance – Bridge Replacement – 4 Lane

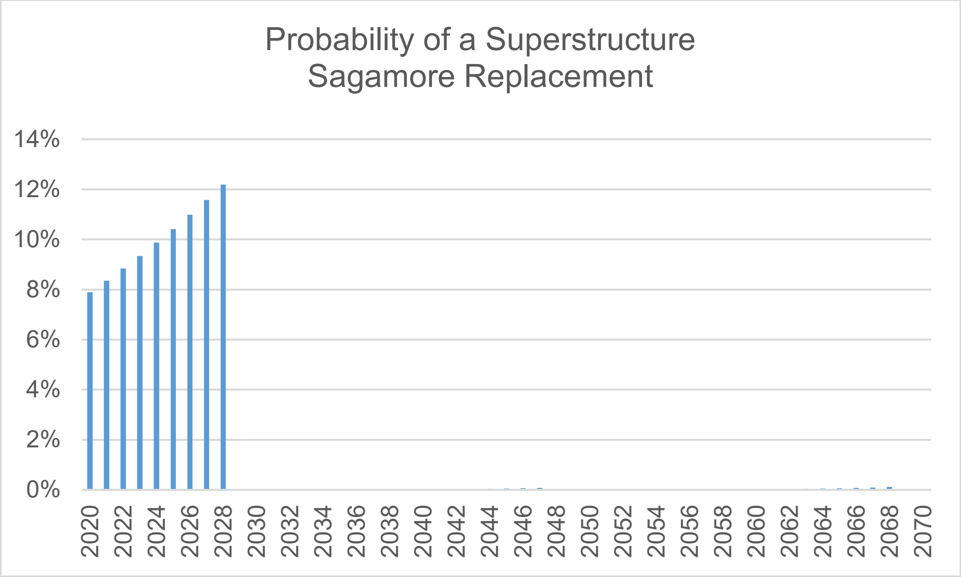
The replacement bridge project will result in more reliable bridges with much smaller probabilities of component failures over the life of the bridges. As an example, below are probability of unsatisfactory performance charts for the bridge superstructures for each bridge exemplifying improved reliability functions. Failure probabilities were assumed to be similar for both replacement alternatives (bridges with or without auxiliary lanes).

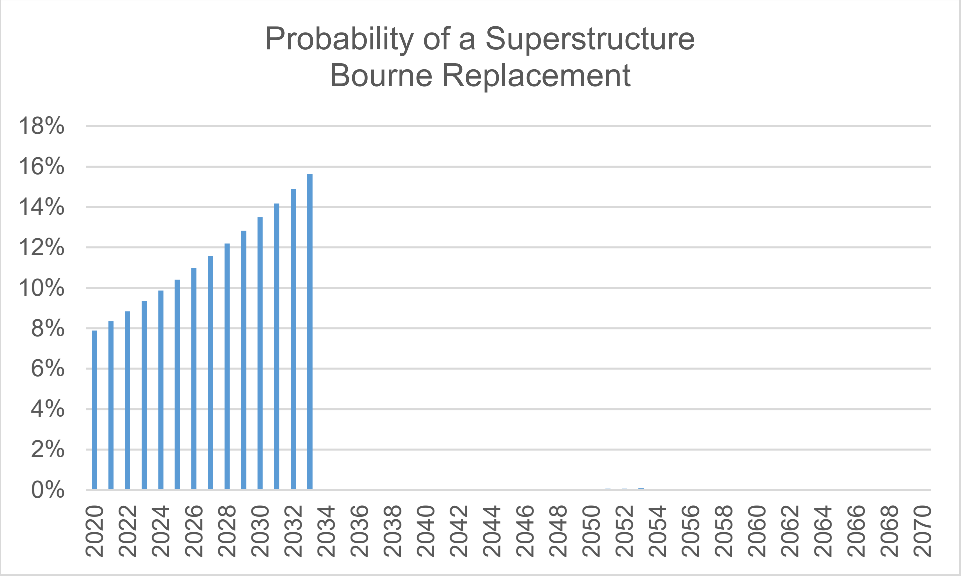
The probability of a superstructure failure would be reset to 0 when the replacement project is complete. The probability of failure (see Figure 20) will slowly rise throughout the forecast horizon and will again be reset after scheduled major repairs. The probability of failure in the superstructure will slowly rise throughout the forecast horizon, reaching 0.05% in 2069 for the Sagamore Bridge and 0.03% for the Bourne Bridge compared to 1.7% in the base condition. By comparison, the base condition probability of failure raises to 64.9% by 2069.

The probability of a bridge deck and substructure failures would each be reset to 0% when the replacement project is complete. The probability of failure of these components will slowly rise throughout the forecast horizon and would be reset to 0% again during scheduled major repairs. The probability of deck failure will be near nil for the remainder of the forecast (below 0.2%) following the replacement project. By comparison, the Base Condition reached 37.4% for the decks in the final year of the evaluation. The probability of substructure failure will slowly rise throughout the forecast horizon, reaching 0.05% in 2069 for the Sagamore Bridge and 0.03% for the Bourne Bridge compared to 1.7% in the Base Condition.

Following the Bridge Replacement project, the event trees used to predict the severity of a component failure will be different for the new bridges. The replacement project will hinder the occurrence of more severe component failures. Please see Appendix D – Economics, for further discussion of event trees for the three bridge components.

Figure 20 – Bridge Replacement Failure Probability – Bridge Superstructure





8.5.2 Benefits, Unsatisfactory Performance, and Monte Carlo Simulation

The repair, navigation, and travel costs are determined as described in the same process as the Base Condition and Major Rehabilitation using Monte Carlo Simulation. The results for the replacement bridges are presented in the table below and detailed in Appendix D – Economics (Table D-72).

Table 29 – Bridge Replacement Plan D - 6 Lanes - Annual Costs ($000s)					
FY 2020 ($000)	**Repair Cost**	**Navigation Cost**	**Travel Cost**	**O&M**	**Total**
Sagamore Bridge Replacement 6 Lanes Annual Costs					
Mean	300	0.1	4,000	200	4,500
Bourne Bridge Replacement 6 Lanes Annual Costs					
Mean	500	0.2	6,300	200	7,000

8.5.3 Benefits of Reduced Congestion – Bridge Replacement Plan D

One additional benefit of the 6-lane replacement bridge is the improved traffic patterns with the addition of acceleration/deceleration lanes on the bridge decks and approaches. The method described earlier using analysis of vehicle hours traveled, was used to compare the value of time in traffic with the 6-lane bridge and compared it to the Base Condition. The annual total time savings is displayed in the table below (Appendix D, Table D-51).

Table 30 – Benefits of Reduced Congestion Bridge Replacement with Through Travel and Auxiliary Lanes			
Cost ($000) FY2020 Prices	**Sagamore Bridge**	**Bourne Bridge**	**Replacement of Both Bridges**
Total Benefit	3,500	800	4,200
Annual Benefit	100	30	200

The benefits are fairly minimal due mainly from the fact that the approach infrastructure, owned by the State of Massachusetts, is not assumed to be improved. The current infrastructure, especially around the Bourne Rotary, is limited. This limits the benefits to avoiding traffic conflicts due to slower traffic entering and exiting the bridges from and to the connecting surface roads immediately inshore of the abutments. On the existing bridges and the In-Kind 4-Lane Replacement Bridges this traffic is merged with the right-hand travel lane, limiting through traffic to one lane in each direction on each bridge.

To determine the benefit of the Bridge Replacement alternative, the cost savings are determined by subtracting the costs for in the Bridge Replacement from Base Condition total costs. The benefits are detailed in the table below.

Table 31 – Bridge Replacement 6 Lanes – Benefits			
Costs/Benefits ($000) FY2020 Prices	**Base Case Total Cost**	**New Bridges Total Cost**	**Benefit**
Sagamore Bridge Replacement 6 Lanes Benefits			
Mean	$123,900	$4,500	$119,400
Bourne Bridge Replacement 6 Lanes Benefits			
Mean	$65,200	$7,000	$58,200

The occurrence of a component failure would decline over the study period after the replacement bridges are constructed. Therefore travel delay costs typically associated with these failures similarly are reduced. In addition, annual O&M costs for the new bridges are reduced. The measurable benefit of replacing the bridges is the total cost savings of $119.4 million annually for the Sagamore Bridge and $58.2 million annually for the Bourne Bridge.

8.5.4 Cost of Bridge Replacement Plan D

The costs of Bridge Replacement Plan D construction is comprised of the total construction cost of the bridges, impacts to navigation during construction, future operations and maintenance, and future repairs to the new bridges during the 50-year project economic life. There will be only limited impact to traffic as the new bridges will be constructed adjacent to the existing bridges. There will be some disruption to vessel traffic during the initial construction and travel delays will be incurred during regular maintenance repairs over the life of the new bridges.

The majority of costs for this alternative will be incurred at the beginning of the construction timeline. As shown in the table below, the total cost of the construction for the new Sagamore Bridge is $501.9 million, and $729.7 million for the Bourne Bridge. A major rehabilitation of the new bridges will not be necessary during the 50 year period, though there will be scheduled repairs.

Table 32 – Bridge Replacement Construction Costs – 6 Lanes Plan D				
Project Costs in $000s FY2020 Price Levels (Updated March 2020)	**Sagamore Bridge Construction Cost**		**Bourne Bridge Construction Cost**	
	Years	**Cost**	**Years**	**Cost**
New Bridges	2025-2029	$428,281	2030-2034	$630,773
State Approaches	2025-2029	$57,802	2030-2034	$90,991
Major Repairs	2048	$7,906	2054	$7,911
Major Repairs	2069	$7,906	- - -	- - -
Total Cost		$501,895		$729,675

8.5.5 Future Traffic Delay Cost with Bridge Replacement Plan D

There are no expected lane or bridge closures during construction of the new bridges as they will be constructed adjacent to the existing bridges. Though some impacts to traffic could be expected during state modification to the approach roads. The existing bridges will continue to operate until the construction is completed and then traffic will be redirected with minimal impact on traffic delays. However, during the scheduled repairs that are expected to occur later in the 50-year timeframe, there will be impacts to traffic. Table 38 below shows the construction costs, navigation costs, and associated travel costs for Bridge Replacement.

Table 33 - Bridge Replacement Plan D – 6 Lanes Costs (Updated March 2020)

Year of New Bridge Construction or Major Repairs	Cost of Construction ($000)	Navigation Cost ($000)	Travel Cost ($000)	Total Cost by Year Incurred
Sagamore Bridge Replacement - 6 Lanes Costs				
2025-2029	$486,100	$200	$0	$486,300
2048	7,900	0	46,300	54,200
2069	7,900	0	46,300	54,200
Total	$501,900	$200	$92,600	$594,700
Bourne Bridge Replacement - 6 Lanes Costs				
2030-2034	$721,800	$200	$0	$722,000
2054	7,900	0	22,200	30,100
Total	$729,700	$200	$22,200	$752,100
Note: Costs are discounted in final analysis				

8.5.6 Total Annualized Cost – Plan D Bridge Replacement

The total costs are annualized to determine the annual cost over the 50 year study as shown in the table below. The construction time duration used for the interest during construction (IDC) is five years.

Table 34 – Bridge Replacement 6 Lanes - Total Annualized Cost ($000) (Costs and Benefits Updated February-March 2020)		
FY2020 Price Levels	**Bourne Bridge**	**Sagamore Bridge**
Construction Cost of Replacement	$721,800	$486,100
Construction Cost of Additional Repair Work	7,900	15,800
Travel and Navigation Delay Costs	22,400	92,800
Total Project Costs	$718,600	$561,400
Discount Factor	2.75%	2.75%
Capital Recovery Factor	0.03704	0.03704
Discounted Cost of Replacement Cost	$521,600	$402,300
Discounted Additional Repair Work	3,100	5,700
Discounted Travel and Navigation Delay Cost	8,900	33,500
Interest During Construction (IDC)	40,800	27,500
Total Cost	$574,400	$469,000
Annualized Cost	$21,300	$17,400
See Appendix D, Economics, Tables D-74 and D-75.		

8.5.7 Plan D Bridge Replacement – Results of Economic Analysis

The total net benefits of Bridge Replacement are determined by comparing total project costs of replacement with total project cost of the Base Condition. Decreased emergency repairs following component failures on the existing bridges under the Base Condition is compared to the total cost of the Replacement Bridges, including design and construction costs, navigation and traffic costs, and scheduled repairs. Table 35 shows the economic analysis for Bridge Replacement with 4 through-traffic lanes plus 2 auxiliary lanes, including total benefits, costs, net benefits, and benefit-cost ratios. Please see Appendix D – Economics (Table D-76), for further discussion of the BCRs.

Table 35 – Bridge Replacement 6 Lanes Annual Cost and BCR				
FY2020 ($000)	**Benefit**	**Cost**	**Net Benefit**	**BCR**
Sagamore Bridge Replacement – 6 Lanes – Annual Cost and BCR				
Mean	119,500	17,400	102,100	6.9
Bourne Bridge Replacement – 6 Lanes – Annual Cost and BCR				
Mean	58,300	21,300	37,000	2.7

8.5.8 Summary of New Bridge Replacement Plan D

The results indicate that Bridge Replacement with construction of two new 6-lane bridges has a higher benefit to cost ratio than maintaining the bridges in a “fix-as-fails” Base Condition. In addition, the cost-benefit ratios are also higher than for Major Rehabilitation of the existing bridges. This study showed that replacement of both bridges results in positive net annual benefits and benefit-cost-ratios greater than 1. The impact of traffic delays is a major component in adding economic costs, highlighting the importance of these structures in traffic flows. The Bridge Replacement alternative limits the impact on traffic which economically outweighs the higher upfront cost.

8.6 Extended Life Value of New Bridges

The fifty year study period (2020-2069) is used to compare alternatives with the Base Condition. Fifty years captures the economic environment expected during that standardized time and does not measure the life of each alternative. At the end of the fifty-year study period in 2069, the bridges will not be in equal condition across all alternatives. According to the American Association of State Highway and Transportation Officials (AASHTO) the design life of bridges constructed today is seventy-five years. Therefore, the Bridge Replacement alternatives have an expected life significantly beyond 2069. Given that construction on the replacement Sagamore Bridge is expected to be completed in 2029, the 75-year design life of the bridge will extend to 2103. Similarly, the Bourne Bridge is expected to be completed in 2034 and therefore the life of the bridge will extend to 2108. In addition, over the fifty year study period there will be two scheduled major repairs that will help to further extend the lives of the new bridges.

In contrast, the current bridges have already exceeded eighty-five years. Major rehabilitation projects can extend the life of the bridges but will be required more frequently as time progresses. In addition, the size of the continual rehabilitation projects are expected to escalate as time passes. These future costs for rehabilitated bridges will be more expensive than the scheduled repairs to extend the life of the new replacement bridges.

8.7 Summary of Economic Results and Conclusions

The results of the economic analysis of the four alternatives is shown below in Table 41 for the Sagamore and Bourne Bridges.

Based solely on Net Annual Benefits from the economic analysis, the rank of alternatives is as follows. The results are the same for each bridge individually.

2. Alternative D: Bridge Replacement with two 4-lane bridges with auxiliary on/off lanes
3. Alternative B: Major Rehabilitation of the two existing bridges
4. Alternative A: Base condition - continue to maintain the bridges with regularly scheduled maintenance and make emergency funding available when there is a component failure.

The economic analysis suggests that the Base Condition – Plan A, fixing the current bridges as components deteriorate, will lead to escalating costs, particularly costs for travelers delayed in traffic.

Table 36 – Economic Summary

Scenario Simulation Comparison Costs ($000) (Updated March 2020)	**Repair Cost**	**Rehab or Construction Cost**	**Benefits**	**Net Benefits**	**BCR**
Sagamore Bridge Summary Results					
Base Condition (Alternative A)					
Mean	123,900	-	-	-	-
Median	119,000	-	-	-	-
Major Rehabilitation (Alternative B)					
Mean	8,800	35,900	115,100	79,200	3.2
Median	6,600	35,900	112,400	76,500	3.1
Replacement Bridge 4 Lanes with 2 Auxiliary Lanes (Alternative D)					
Mean	4,400	17,400	119,500	102,100	6.9
Median	2,900	17,400	116,100	98,700	6.7
Bourne Bridge Summary Results					
Base Condition (Alternative A)					
Mean	65,200	-	-	-	-
Median	62,700	-	-	-	-
Major Rehabilitation (Alternative B)					
Mean	6,100	27,100	59,100	32,000	2.2
Median	4,800	27,100	57,900	30,800	2.1
Replacement Bridge 4 Lanes with 2 Auxiliary Lanes (Alternative D)					
Mean	6,900	21,300	58,300	37,000	2.7
Median	4,200	21,300	58,500	37,200	2.7
Note: From Appendix D – Economics – Tables D-77 and D-78					

Plan B – Major Rehabilitation of both existing bridges demonstrated positive net benefits and a benefit-cost-ratio of 3.2 for the Sagamore Bridge and 2.2 for the Bourne Bridge. One advantage of the Major Rehabilitation is a lower initial construction cost for the project when compared to replacing the bridges. The disadvantages are the impact it will have on traffic patterns during the time of construction due to lane and full bridge closures as well as the bridges not being brought up to current engineering standards and regulations. Continued deterioration over time and escalating frequency of future repairs and additional rehabilitation are also concerns.

Alternatives for replacement bridges were also evaluated for two 4-lane bridges with auxiliary on/off lanes (Plan D). These alternatives had higher net benefits and BCRs than the Major Rehabilitation alternative. One disadvantage of the new bridges is the high initial construction cost. On the other hand, advantages of the Bridge Replacements are minimal disturbances to traffic during construction and replacing the aging infrastructure with bridges that meet current engineering standards and regulations. The new bridges will also have far less future repair costs and traffic delays over the project life cycle.

It is important to note that this analysis was performed under the assumption that the infrastructure and surrounding roadways to the bridges remain in their current conditions and are not upgraded by the state of Massachusetts. If the state chose to improve the road network surrounding the bridges, particularly near the Bourne Rotary, then the replacement bridges with auxiliary on/off lanes added would provide benefits of improved travel time that could increase the net annual benefits and BCR. The 6-lane replacement bridges could also reduce the impact to the traveling public when performing future maintenance on the bridges as additional lanes would be available. Please see Appendix D – Economics for a detailed economic analysis of the alternatives.

9.0 ENVIRONMENTAL CONSIDERATIONS AND ANALYSIS

This MRER and the accompanying Phase I EA document the analysis and decision process for determining the best solution for ensuring long-term safe, reliable, and cost effective vehicular access across the Cape Cod Canal. This chapter summarizes the information and analyses contained in the Phase I EA including discussion of the resources within the project area and consideration of potential impacts based on a conceptual bridge design and a preliminary estimated project area. Resources and potential impacts will be more fully defined and analyzed when the project moves to the design and construction phase (Phase II).

9.1 Affected Environment and Environmental Consequences

9.1.1 Land Use

The affected area is covered by transportation infrastructure, residential and commercial properties, and forested land. Property owned by the U.S. Government and administered by the USACE at the Cape Cod Canal includes a total of 1,153 acres; of which 982 acres of land is situated along the 7.7 mile land cut of the Canal. Approximately 20% of the government-owned property is developed. Within the developed areas are 10 USACE-operated recreation areas. The Canal has riprap embankments along the shoreline with service roads running along both sides of the canal. This USACE property is used for Canal maintenance access as well as public recreational access.

Plan A – Base Condition – No Action: No changes would occur to existing land uses because with routine and emergency maintenance bridge alignments would remain the same, and no other changes to the bridges footprint would occur. There are no other foreseeable changes to land use or land cover related to the bridges remaining in their current position with no major changes to their configuration and function.

Plan B – Major Rehabilitation: Major rehabilitation of the bridges would cause temporary localized impacts from construction and maintenance activities, but the permanent bridge structures would all continue to occupy the same footprint. Past maintenance and rehabilitation efforts were completed without adverse effects to land use and physical resources. Any disturbed sites would be returned to pre-project conditions following the completion of major rehabilitation.

Plan D – Bridge Replacement: Localized, permanent impacts adjacent to the existing highway bridges would occur where the replacement bridge would be constructed. The bridge piers, abutments, and landings would be in slightly different locations and thus result in permanent land use impacts. Under Alternative D, the footprints would be slightly larger because of the two auxiliary lanes on each bridge. The affected land uses by the new bridges under both alternatives are commercial, transportation, forested, and residential. The construction staging areas would be returned to pre-project conditions where possible.

9.1.2 Terrain and Topography

The terrain around the bridges varies in elevation, generally rising with distance away from the Canal in the project area. Elevations in the study areas range from sea level to approximately 100 feet above MSL around the Sagamore Bridge, with an increase in elevation around the Bourne Bridge of 50 to 100 feet above MSL.

Under both the Base Condition (Plan A) and Major Rehabilitation (Plan B) there would be no impacts to terrain and topography with routine bridge maintenance or major rehabilitation because no changes to existing grades are anticipated. With bridge replacement (Plan D) re-grading of some surrounding areas to accommodate the new bridge approaches and abutments will be required for new bridges. Until specific bridge designs are available, the exact extent of these modifications is unclear and will be fully defined in Phase II of the project.

9.1.3 Geology and Soils

Cape Cod is composed of glacial end moraines, which mark the approximate locations of the ice front and outwash plains formed by sediments deposited by streams of melt water from the glaciers. The result is a series of connected, broad, sandy plains and hilly terrain. Sediments at the east end of the Canal were deposited in a lake that formed in Cape Cod Bay between the retreating ice front and the Sandwich moraine. A significant amount of soils around the Canal are Udipsamments, i.e. the original soil was excavated or filled during construction. The bedrock surface elevations in the vicinity of the Canal range from roughly -125 to -175 feet MSL.

Under the Base Condition (Plan A) and Major Rehabilitation (Plan B) there are no impacts because the existing bridge structures would remain in place and only activities related to routine maintenance or rehabilitation of the existing structures would occur. Bridge replacement (Plan D) would have no long term effect on geology and soils. Surface soils in currently managed areas may be disturbed by construction activities during the course of work on the bridge approaches and abutments and the creation of temporary laydown areas, and also for altering the configuration of approaches

9.1.4 Climate

Barnstable County experiences average high temperatures ranging from 80 degrees Fahrenheit (°F) in July to 38°F in January and average low temperatures ranging from 63°F in July to 20°F in January. Average annual precipitation is 47.63 inches, with the month of March generally receiving the most precipitation and the month of July receiving the least (NOAA, 2016). Extreme weather varies in Barnstable County from drought conditions to hurricane events. None of the alternatives would have direct or indirect impacts to the climate of the region. Routine operation and maintenance, replacing or rehabilitating existing bridges, or replacement of the two bridges will not have any appreciable effects on climate in the region because of the limited potential of these activities to influence long term temperature and weather trends.

9.1.5 Air Quality

The Clean Air Act (40 CFR Part 50) requires the U.S. EPA to set, and states to adopt, National Ambient Air Quality Standards (NAAQS). EPA has set NAAQS for six pollutants: Carbon Monoxide (CO), Lead (Pb), Nitrogen Dioxide (NO2), Particulate Matter with a diameter less than or equal to ten micrometers (PM10) and less than 2.5 micrometers (PM2.5), Ozone (O3), and Sulfur Dioxide (SO2). Both bridge replacement projects are located within Barnstable County which is currently designated as an Attainment Area for all NAAQS. The project area is in attainment of all of the applicable NAAQS; therefore, transportation conformity rule requirements do not apply for this region.

None of the Alternatives will result in permanent air emissions or long-term impacts to air quality providing Best Management Practices (BMPs) are incorporated at the time of scheduled construction activities. No impact to local or regional air quality should occur as the result of the proposed project.

Bridge routine and emergency maintenance (Plan A), as well as major rehabilitation (Plan B) activities, have the potential to cause a temporary increase in air emissions due to traffic backups and delays associated with this work. Bridge replacement (Plan D) will not significantly affect regional air quality levels because existing bridges will remain open until new bridge construction is completed, thereby reducing traffic and associated air emissions.

Short-term/temporary impacts to air quality may occur during the construction period for any bridge replacement. Emissions from fuel-burning internal combustion engines (e.g., heavy equipment and earthmoving machinery) could temporarily increase the levels of some of the criteria pollutants. Short term impacts resulting from dust, construction vehicles, and related equipment are expected to be minor and should not have an extensive impact on local air quality.

MassDOTs air quality study was used to assess the potential for increased or decreased air quality impacts within the study area utilizing EPA and FHWA guidelines. The evaluation determined that regardless of the option chosen, vehicle emissions would likely be lower than present levels because of the EPA's national air quality control programs mandated under the federal Clean Air Act. The MassDOT preliminary air quality evaluation can be viewed in Appendix E. MassDOT plans on conducting additional air quality analyses in the next phase of the project to evaluate existing and future air quality impacts.

9.1.6 Lead Paint

Though they have been repainted many times, the existing paint system on both bridges still contains lead paint. Even areas that have been repainted contain residual amounts of lead. Routine maintenance (Plan A) and major rehabilitation (Plan B) will require removal of lead containing paint from both bridges. During the design and construction phase, a Total Suspended Particulate (TSP) Monitoring Plan will be developed and TSP-lead monitoring will be conducted. Replacement of the existing bridges (Plans D) would also include demolishing the old bridges and may produce lead contaminated blast debris. All work will be performed in accordance with applicable environmental regulations, BMPs as well as worker health and safety standards, including containment, emissions monitoring, collection, and disposal of all contaminated blast debris and as such, there will be no significant impacts to air quality.

9.1.7 Surface Water and Wetlands

The Cape Cod Canal FNP connects Buzzards Bay and Cape Cod Bay, and has significant tidal exchange with those water bodies. The project area has several man-made ponds and freshwater wetlands. The location and description of these ponds can be found in the Environmental Assessment. All of these ponds are less than a half-acre in size, and are surrounded by the roadways of the Sagamore Bridge approach. The slope and topography of this area indicate these ponds drain the land within the approach, which are at a higher elevation than the surrounding natural landscape.

The USFWS National Wetlands Inventory (NWI) shows forested wetlands in the Bourne Bridge area. Finally, there is an area of estuarine marsh between the bridge and Old Bridge Road on the northern shore of the Canal. A USACE field inspection conducted on April 15, 2019 confirmed the location of wetlands found in the Federal and State online databases.

An additional area of forested wetland approximately 50 by 100 feet in size (0.5 acres), is located roughly 500 feet east of the Bourne Bridge on the northern shore of the Canal. The Herring River Watershed is located west of the Sagamore Bridge study area on the mainland side of the Canal. This watershed is designated by the state as an Area of Critical Environmental Concern (ACEC) for its importance to anadromous fish and other wildlife.

With both Plan A – Base Condition and Plan B – Major Rehabilitation, there would be no impacts to surface water and wetland resources because activities would take place only around existing structures where no wetlands are identified. Thus, only the area of the Canal where the piers are currently situated would continue to have impacts from routine maintenance or major rehabilitation, as well as by the presence of construction support barges in the event they might be required. Routine maintenance or major rehabilitation in the future would not involve any wetland impacts outside of the Canal.

Under Plan D for Bridge Replacement nearby wetlands and ponds may be temporarily affected by construction activities. The man-made ponds in the Sagamore Bridge approach would be affected as the abutments would have to be moved further back, and Nightingale Pond in the Bourne Bridge area would be avoided. No adverse impacts are expected for the ACEC and Nightingale Pond. The Canal shoreline would also receive new proposed bridge piers, as they would be relocated out of the water. The shoreline in this area is rock/riprap, and is located on USACE property. The forested wetland 500 feet east of the Bourne Bridge on the northern side of the Canal touches the easternmost boundary of the area affected by the new alignment. This half-acre wetland would be most impacted by Plan D because of the extra width imposed by the auxiliary lanes. Mitigation measures would need to be developed during the design phase for any impacts to this wetland from bridge replacement.

9.1.8 Water Quality

Water quality was considered for both fresh and salt water resources in the project area. The saltwater environment in the Canal is subject to the diurnal tidal cycle in connection with Cape Cod Bay and Buzzards Bay, creating a swift current that can reach 5.2 mph during the ebb tide. Water quality in the Canal is affected by the large volume of maritime traffic that passes through on a daily basis. The Massachusetts Department of Environmental Protection designates the Canal as “Class SB,” meaning that the waters of the Canal are designated for fish, other aquatic life and wildlife, and for primary and secondary contact and recreation.

Surface water on land is affected by runoff from the urban landscape and high volume of road traffic that passes over the Canal bridges. Nitrogen pollution from residential septic systems is a major concern on Cape Cod, as it can travel quickly through groundwater into ponds and coastal waters, causing algal blooms that negatively affect marine life (Dunn, 2018).

For the Base Condition – Plan A, there would be no impacts to water quality because there would be no change to existing conditions around the bridges. Routine maintenance operations would require construction activity on-site, but these operations have occurred for decades with no adverse water quality impacts. Major Rehabilitation (Plan B) would have no impacts on water quality.

Bridge Replacement (Plan D) is not anticipated to have any substantial effect on water quality because impacts to regulated water resources would be minimized through avoidance and minimization during the design and construction phase.

9.1.9 Groundwater

Regional groundwater occurs in alluvial and bedrock aquifers. The Cape Cod Aquifer is a bedrock aquifer and is designated as the principal source of drinking water for residents of

Cape Cod designated by EPA as a Sole Source Aquifer. This designation means that the Aquifer supplies at least 50 percent of the drinking water consumed in the area above it. The regional water bearing units of the Cape Cod Aquifer are further described in detail in the Environmental Assessment.

Under the Base Condition – Plan A, there would be no impacts to groundwater because no actions would occur that could affect regional or local groundwater patterns. There would be no impact to groundwater under Plans B or D. These actions would not affect the Cape's high rates of surface water infiltration, and the effects of construction activities would not change the underlying hydrogeology of the area either directly or indirectly by rehabilitating or replacing the bridges.

9.1.10 Floodplains

Executive Order (EO) 11988 (Floodplain Management) requires Federal agencies to avoid direct or indirect support of development within the 100-year floodplain whenever there is a practicable alternative. The Federal Emergency Management Agency (FEMA) National Flood Insurance Program (NFIP) publishes maps identifying areas at risk from potential flooding. Flood maps were examined during the preparation of this MRER and EA. The bridges cross a major waterway and are located in two zones: X - 0.2% Annual Chance of Flooding or Area of Minimal Flood Hazard (500 year floodplain), and AE - 1% Annual Chance of Flooding, with Base Flood Elevations (100 year floodplain). There will be no significant impact to, or alteration of, floodplains or flood levels associated with any of the alternatives as both bridges are located over an existing federal navigation channel and adjacent to developed land.

9.1.11 Coastal Zone

The Coastal Zone Management Act (CZMA) enables coastal States, including Massachusetts, to designate State coastal zone boundaries and develop coastal management programs to improve protection of sensitive shoreline resources and guide sustainable use of coastal areas. All of Cape Cod and the islands of Nantucket and Martha's Vineyard are included in the Massachusetts coastal zone boundary. Both the Sagamore and Bourne bridge project areas are located within these coastal boundaries.

Under both the Base Condition – Plan A and Major Rehabilitation (Plan B) no new construction would occur within the coastal zone and activities associated with repair or rehabilitation of the existing bridges would not result in any short or long-term impacts to coastal resources within the project area. The Bridge Replacement (Plan D) will have no significant impact on the coastal environment. The project will preserve all coastal resources including the immediate waterfront and waterway for both recreational and vessel-related activities.

9.1.12 Coastal Barrier Resource System

Coastal barriers are unique landforms that protect coastal mainland areas from severe coastal storm damage and erosion and are important wildlife habitat and recreational areas. The

Coastal Barrier Resources Act (CBRA) of 1982 established the Coastal Resources System which includes undeveloped coastal barriers along nation's coastlines. The Bourne and Sagamore Bridges project areas are located outside of CBRA System Units and Otherwise Protected Areas.

9.1.13 Vegetation

Cape Cod is situated in the Atlantic Coastal Pine Barrens ecoregion, a globally rare habitat type that only exists on the Cape and Islands, Long Island, and New Jersey. The 2017 Environmental Assessment and Finding of No Significant Impact for the Cape Cod Canal Photovoltaic Installation documented land cover and vegetation for areas adjacent to the Sagamore Bridge and the nearby Midway Recreation Area, providing an overview of vegetation and land cover within the canal bridges study area and the surrounding landscape. There are patches of forested land in the study area, composed of oak-pine and scrub-oak communities. Forested areas occur within 1000 feet of both bridges, and these are interspersed among roads and development. The shorelines of the Cape Cod Canal are primarily rip rap, and above that hard shoreline is a grassy area with occasional tree cover on the transition zone between the water and Canal Service Roads for both bridges. This is a man-made, heavily managed shoreline used for recreation and navigation purposes.

With the Base Condition (Plan A) there would be no impacts to vegetation as no changes to existing conditions would occur with this Alternative. Under the Major Rehabilitation (Plan B) there would be some disturbance of roadside vegetation, but the impacts would be minimal because the scope of work is largely confined to the existing rights-of-ways. With Bridge Replacement (Plan D) there would be localized permanent impacts on vegetation where the bridge approaches, piers and abutments are relocated. A new bridge would be constructed immediately to the east of the Bourne Bridge, and another bridge immediately to the west of the Sagamore Bridge. Forested areas adjacent to the bridges would undergo permanent changes as outlined in the Land Use section of this document.

9.1.14 Wildlife

Mammals: There are a variety of mammals on Cape Cod inhabiting the diverse landscape, from the coastal pine barren forests to seashore environments. Mammals on Cape Cod were affected by habitat conversion in the early 19th century from woodland to farmland, and there was some recovery when agriculture moved westward. Several small terrestrial mammals potentially use the habitat areas surrounding the Bridges and these species are described in Environmental Assessment.

Birds: The Canal is an important corridor for birds traveling between Massachusetts Bay and Buzzards Bay. The Corps has implemented programs to increase use of the Canal by birds such as ospreys (*Pandion haliaetus*) and screech owls (*Megascops asio*).

Under the Base Condition (Plan A) there would be no impacts to wildlife under the no action alternative because existing conditions would continue. Routine maintenance activities have not negatively impacted bird and other mammal populations around the bridges in the past and are not expected to do so in the future. With Major Rehabilitation (Plan B) there may be minimal, temporary effects on wildlife because of the noise and duration of construction activities associated with major rehabilitation. However, these impacts are not expected to be significant because the noise from construction vehicles will likely deter animals from the construction site.

With Bridge Replacement (Plan D) impacts to wildlife are possible because of the changing footprint of new bridges, including the movement of the piers from within the Canal to an upland setting, as well as extending the approaches. These changes would take place in the regularly-dredged Canal and existing network of transportation infrastructure around the bridges. The piers would be moved to an upland setting that is already mowed and maintained by USACE. Wooded upland habitat used by wildlife would be affected, as well as marine epifauna living on the bridge piers and species that feed on them, but these impacts will be confined to the project area and further articulated in Phase II.

If new bridges are built, the decision to leave the old bridge piers in place or remove them will be determined during the next phase of the project (Design Phase) and will depend on factors such as new bridge type, alignment and configuration. The old piers would most likely be in the way of new bridge construction and would therefore need to be removed. Also, the piers were constructed to support a significant portion of the weight of bridges. Removing that weight could have detrimental effects on the overall stability of the piers. They were not built to be free standing structures. At this preliminary phase, there is currently no engineering justification to leave the piers in place. Also, if left in place they could pose a navigation safety hazard and would require ongoing inspections and maintenance.

Discussions with the Resource Agencies related to any potential impacts to marine epifauna associated with either the removal of existing piers or leaving them in place, will also be conducted during the next phase of the project (Design Phase). Both U.S. Fish and Wildlife Service and National Marine Fisheries Service have concurred with this approach. Agency Concurrence letters will be added to Appendix E.

9.1.15 Fisheries, Marine Wildlife and Essential Fish Habitat

The Canal is an important recreational fishery because of its swift currents and connectivity between Buzzards and Cape Cod bays. The Bournedale Herring Run entrance is located about one mile west of the Sagamore Bridge, and provides access for Alewife and Blueback Herring to spawn in Great Herring Pond. A March 1991 USACE survey of benthic habitat on the western edge of the Canal found no macrofauna, but did locate other sporadic marine ecological communities. There are recorded spawning sites within Buttermilk Bay to the west, but none within the Canal land cut. There is no eelgrass in the Canal's Federal navigation channel, but it is found outside of the channel near Hog's island on the western end of the Canal approaches.

Essential Fish Habitat: The 1996 amendments to the Magnuson-Stevens Fishery Conservation Management Act (MSA) strengthen the ability of the National Marine Fisheries Service (NMFS) and the New England Fishery Management Council to protect and conserve the habitat of marine, estuarine, and anadromous finfish, mollusks, and crustaceans. This habitat is termed "Essential Fish Habitat," (EFH) and is broadly defined to include, "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity." The Cape Cod Canal falls into this category for multiple fish species, which are described further in the Environmental Assessment.

With the Base Condition (Plan A) there would be no effects on EFH species because routine and emergency maintenance would not require in-water work. Under Major Rehabilitation (Plan B) in-water work or elevated noise levels in the water due to major rehabilitation construction may have minimal temporary impacts on EFH species, and coordination would need to be undertaken with NMFS pursuant to the MSA during Phase II.

With Bridge Replacement (Plan D) underwater work related to the removal of existing bridge piers may affect EFH or fish species. Construction or placement of new bridge components from the water and demolition of the existing bridges may also have impacts on fisheries. Further, the USACE proposes to move the bridge piers from the water to the Canal shoreline, thus removing those structures as habitat. Further coordination would be required in Phase II.

9.1.16 Threatened and Endangered Species

Federal Threatened and Endangered Species: The Corps conducted an initial screening of the proposed project site utilizing the US Fish and Wildlife Service (USFWS) Information for Planning and Consultation (IPaC) webpage and as well as requesting an official species list from USFWS. These records indicate that the federally-threatened northern long-eared bat (NLEB; *Myotis septentrionalis*), endangered northern (Plymouth) red-bellied cooter (*Pseudemys rubriventris*), endangered American chaffseed (*Schwalbea americana*), roseate tern (*Sterna dougalli dougallii*), piping plover (*Chadrius melodus*), and red knot (*Calidris canutus*) may occur in the project area. The EA provides a map of federally-listed species and critical habitat occurring in or near the study area. The northern long eared bat may occur in the study area but has a widespread distribution. American chaffseed is not found in the study area, and the several bird species are present in a transient or migratory nature. Further discussion of the Threatened and Endangered Species can be found in the Environmental Assessment.

Under the Base Condition there would be no effect on federally listed species because there would be no change in existing conditions for routine maintenance of the bridges. Under the other three plans the project would likely have no effect on federally listed species, except for Northern Long Eared Bat (NLEB) which may roost under the bridges. USACE will conduct surveys and will consult with USFWS pursuant to Section 7 of the Endangered Species Act (ESA) to determine if NLEB are present and identify measures necessary to minimize potential impact. USACE will also consult with NMFS in Phase II of the project to protect federally listed species.

Both U.S. Fish and Wildlife Service and National Marine Fisheries Service have reviewed the Draft EA and concurred with this approach. Agency Concurrence letters will be added to

Appendix E. Based on our conversations with the resource agencies the risk of a jeopardy determination is extremely low.

State Listed Threatened and Endangered Species: Forty-six species are listed by the Massachusetts Natural Heritage Endangered Species Program (MA NHESP) as occurring in Bourne, Massachusetts (see EA). According to the MassGIS, Estimated Habitats of Rare Wildlife and Priority Habitats of Rare Species are not mapped within either bridge site (2019).

The Midway Recreation Area, a USACE parcel adjacent to the Canal is within NHESP Priority Habitat of Rare Species but will not be affected by the proposed project. Coordination with the MA NHESP during the scoping process for the 2017 EA indicated that Eastern Box Turtles (*Terrapene carolina*), a Species of Concern, is known to inhabit the Midway site. Eastern Box Turtles are small, terrestrial tortoises that range from southeastern Maine to northern Florida and as far west as Michigan, Illinois, and Tennessee.

Under the Base Condition (Plan A) and the Major Rehabilitation (Plan B) there will be no impacts to state-listed species because activities will not take place in areas designated as priority habitats of rare species or areas of critical environmental concern. Bridge maintenance or rehabilitation work will take place within the existing bridge footprints and rights of way. With Bridge Replacement (Plan D) there are no estimated habitats of rare wildlife or priority habitats of rare species within the study area, so no impacts to state-listed wildlife are expected.

9.1.17 Environmental Justice

It is important that any construction project under consideration by the federal government ensures that it does not negatively impact socially vulnerable populations. The EPA defines Environmental Justice as the "the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income, with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies". Impacts to vulnerable populations as pertaining to Environmental Justice were evaluated in accordance with Executive Order 12898 – *Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations* signed February 16, 1994 which directs Federal agencies to identify and address the disproportionately high and adverse human health or environmental effects of their actions on minority and low-income populations, to the greatest extent practicable and permitted by law. The EA includes a detailed evaluation of environmental justice issues.

Minority Populations: An examination of census blocks for the Cape and Islands shows that the population is majority white, with only a few pockets of the population with a percentile greater than 50 on Martha's Vineyard, Nantucket, Falmouth, and Barnstable, none of which are in the vicinity of the Canal and its bridges. The data for the five census blocks in the immediate area of the two highway bridges were examined. None of the census study block groups in the project area exceed the percent minority in the state or national average. Therefore, the population in the study area is not considered socially vulnerable as pertaining to minority population.

Low Income Populations: Low-income population is defined by the EPA as the "percent of individuals whose ratio of household income to poverty level in the past 12 months was less than 2" and is calculated using data from the Census Bureau's American Community Survey. Census block data was examined for Cape Cod and the Islands for income. Low-income populations are more prevalent in the region as compared to minority populations. The highest concentration on low-income population is in the town of Barnstable. The center of the Town of Barnstable is 15 miles from the nearest of the Canal bridges. All five census blocks in the vicinity of the two bridges had median household incomes higher than the state average. Also all block groups in the study area are well above the Department of Health and Human Services Poverty Guideline threshold. Therefore, the project will not negatively impact populations that are socially vulnerable due to low-income.

Given that the population surrounding the two Canal highway bridges is not considered socially or environmentally vulnerable, none of the four alternatives is expected to have a negative impact on low-income or minority populations.

9.2 Indirect Impacts

CEQ's NEPA implementing regulations require Federal agencies to consider the potential for indirect effects and cumulative impacts from a proposed project (40 CFR §1508.7, 1508.8). The MRER and accompanying EA evaluates the direct, indirect, and cumulative effects of major rehabilitation or replacement of the Bourne and Sagamore bridges over the Canal and to analyze alternatives to either repair or replace the existing bridges.

Indirect effects are defined as those which are caused by an action, and are later in time or farther removed in distance, but are still reasonably foreseeable. These effects can include inducing changes in patterns of land use, population density or growth rate as well as other related effects on air, water, and other natural ecosystems.

The National Cooperative Highway Research program identifies the following types of transportation projects which might result in indirect effects to a project area: construction of a new highway, highway extensions, or bridges to currently undeveloped areas; new highway bypasses around congested downtowns; new or expanded airports and harbors; new rail transit, new interstate highways, or new interchanges in undeveloped or rural locations (NCHRP, 2002).

CEQ defines "cumulative impact" as "the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or non-federal) or person undertakes such other actions." (40 C.F.R. § 1508.7). The assessment of cumulative effects in this EA addresses the potential impacts from the project and other projects proposed within, or in the vicinity of the Cape Cod Canal bridges study area.

The Cape Cod Canal bridges have been in place since the 1930s. Past and present activities at the Cape Cod Canal include maintenance of the Federal navigation channel and routine maintenance of the Bourne and Sagamore Bridges. Reasonably foreseeable future actions include the continuation of current maintenance and navigation activities as well as connected bridge approach road work required by MassDOT to connect new replacement bridges to existing roadways. MassDOT's conceptual projects and their potential for cumulative impacts to area resources were described in Section 6.5 and in greater detail in Chapter 7 of the EA. Categories of indirect and cumulative impacts are discussed below.

9.2.1 Induced Development

Concerns with additional development on Cape Cod tend to focus on congestion, water supply, sewage treatment and other strains on public infrastructure. In 2012 the Cape Cod Commission estimated that there was capacity for about 28,000 additional residential units and 32 million square feet of commercial space on the Cape. A UMass 2017 study estimated housing demand at about 26,000 units. Near capacity housing, with its impact on resources and infrastructure, is expected to occur regardless of any bridge improvements.

9.2.2 Traffic Impacts

The traffic model only shows a difference in average travel time over the new versus existing bridges during the weekend summer mid-day time period. An increase in speed of 2 miles per hour decreases the average travel time over the average route length by less than 20 seconds. This change in accessibility would translate to no or weak potential for land use change. The Sagamore and Bourne Bridges are not the only source of bottleneck traffic as other Cape roadways also limit flow. Bridge replacement will have only minimal benefitsto traffic problems without improvements of roadways throughout the Cape. Therefore, bridge replacement will not substantially improve access to the Cape or increase the number of visitors and associated development.

MassDOT is planning a number of state highway improvements even without changes in the Canal bridge crossings. These are discussed below under cumulative impacts. Each of these will have some level of traffic impact during construction. State projects for relocating bridge approach roads resulting from bridge replacement will also have impacts on traffic during construction.

One additional benefit of the 6-lane replacement bridge is the improved traffic patterns with the additional acceleration/deceleration lanes. The benefits would be fairly minimal due mainly to the fact that the approach infrastructure, owned by the State of Massachusetts, is not assumed to be improved, only realigned. The current state and local infrastructure, especially around the Bourne Rotary, is limited.

9.2.3 Population Models and Forecasted Growth

Since 2000, population growth slightly decreased in Barnstable County. Population dynamics are largely attributed to a large influx of baby boomers retiring to the region, the subsequent increase in death rates due to an ageing population, and younger populations leaving the region to pursue employment and educational opportunities. While some projections estimate an overall reduction in population on Cape Cod, others estimate an increase in population, though the rates of growth would have little to no potential for land use change in the study area.

Bridge rehabilitation or replacement projects are not expected to lead to significant induced development and will not result in localized or regional indirect effects.

9.3 Cumulative Impacts

9.3.1 State Highway Improvements

The bulk of the cumulative impacts associated with the Canal highway bridges rehabilitation or replacement involve projects to be undertaken by the MassDOT. Some of these are intended to occur in support of bridge replacement. A complete discussion of these projects can be found in the EA, Chapter 7. These state highway projects include:

(1) Bourne Rotary – Route 28 Northbound Ramp to Sandwich Road
(2) Bourne Rotary – Three New Signalized Intersections
(3) Bourne Rotary with Highway Interchange
(4) Belmont Circle – 3 Leg Roundabout plus Signalized Intersection
(5) Belmont Circle with Route 25 Eastbound Fly-over
(6) Belmont Circle – Cape Cod Scenic Highway to Route 25 Westbound On-Ramp
(7) Route 6 – Exit 1C Relocation
(8) Route 6 – Additional Eastbound Travel Lane from Exit 1A to Exit 2 (3 total lanes)

The MassDOT Alternatives are based on the assumption that the USACE will replace both the Bourne and Sagamore bridges. The discussion examines only those conceptual MassDOT projects that could potentially be linked to the replacement of the Bourne and Sagamore bridges. MassDOT alternatives descriptions are taken from that agency's Cape Cod Canal Transportation Study (2019).

Bourne Rotary Alternatives: The first three improvements listed above concern the Bourne Rotary at the Cape Code side of the Bourne Bridge and its connection to local roads. These include intersection improvements, signalization, and ramp and connecting road improvements. None of the three alternatives evaluated for the reconstruction of the Bourne Rotary would impact wetland resources or the 100-year floodplain. A small area of rare species habitat would be impacted by replacing the rotary with a highway interchange. Minor real estate areas would need to be acquired from the town for the State's work.

Belmont Circle Alternatives: Belmont Circle is the intersection of Route 25, Main Street, Scenic Highway, and the Buzzards Bay Bypass. Several alternatives were evaluated to improve traffic operations at Belmont Circle, including signalization, roundabout changes, and a flyover ramp. All include the new Entrance Ramp, Scenic Highway Westbound to Route 25 Westbound project. Only the roundabout alternatives would impact wetlands and the 100-year floodplain. Utility relocations would be required. Some property may need to be acquired.

Route 6 Alternatives: U.S. Route 6 projects include relocation of Exit 1C and addition of a third lane eastbound from the Sagamore Bridge to Exit 2. Exit 1C connects westbound traffic with the local roads, including Route 6A, just before the Sagamore Bridge. There would be no wetland, floodplain, or other regulated water resources impact from the Route 6 Exit 1C relocation. Some rare species habitat could be impacted.

There are no wetlands, floodplains, or other regulated wetland resources within 100 feet of the Route 6 corridor, and there would be no impacts to these resources by the highway widening. About 3.9 acres of land designated as rare species habitat by the state would be impacted, all forested land within JBCC and the Shawme-Crowell State Forest.

9.3.2 Total Cumulative Impact and Significance

If all of the State's large alternatives for each of the improvements listed above were implemented there would be minor impacts to the wetlands, the 100-year floodplain and rare species habitat, mostly due to the Belmont Circle reconstruction and the additional Route 6 eastbound travel lane. All MassDOT plans are conceptual at this phase and none have been authorized or identified for funding. Future MassDOT Cape Cod transportation improvement projects are uncertain at this phase and if identified in the future further analysis will be conducted during Phase II.

9.3.3 Other Development Projects

The USACE contacted the local Conservation Commissions and Planning Boards in the towns of Bourne and Sandwich, MA to identify any current or planned future projects in each community as well as their proximity to the bridges study area. Fifteen projects were identified. Although three of those projects fall within the study area: redevelopment of Cumberland Farms, a proposed new wastewater system, a gas station and an extended stay hotel, all are located in previously developed areas and present no cumulative environmental impacts. All potential projects will be further evaluated during Phase II of the project. At this time it is believed that there will be no significant cumulative environmental impacts from major rehabilitation or replacement of the Bourne and Sagamore Bridges in association with any of the other proposed development projects identified.

9.4 Public Involvement

USACE regulations (Planning Guidance Notebook – ER 1105-1-100) and the National Environmental Policy Act (NEPA) require that all efforts be made to involve the public in preparing and implementing NEPA procedures and to hold public meetings whenever appropriate.

The USACE encourages stakeholder engagement, collaboration, and coordination for all projects and decision-making processes. Agencies, organizations, federally recognized

Tribes, and members of the public with a potential interest in a proposed project were kept informed and invited to participate in the decision-making process for this project. Appendix E provides a record of agency and Tribal coordination associated with the MRER and EA.

The USACE involved the public early in the bridges study planning process to provide open communication and enable better federal decision-making. A series of five public informational meetings were held during the first two weeks of December 2018 in Bourne, Plymouth, Hyannis, Martha's Vineyard, and Nantucket, MA. These meetings introduced the MRER, environmental assessment process, and project timelines. A project website (www.CapeCodCanalBridgesStudy.com) was developed to keep the public informed through presentations, fact sheets, and documents, and provided an additional option for submitting public comments. One hundred four public comment letters or e-mails were received to date and were compiled into a summary matrix for consideration (Appendix F).

Another series of public meetings will be held to allow the opportunity for comments on this phase of the project and the draft MRER and EA. The Corps will notify the public of the availability of the draft MRER and draft EA through publication of a public notice which will begin a 30-day public comment period. Additional public informational meetings will be scheduled during Phase II of the project to discuss the status of the project, design and construction details, and other key project considerations.

9.5 Environmental Coordination

NEPA requires lead Federal agencies to cooperate with other governmental agencies early in a project and throughout the NEPA process. CEQ regulations state that a lead agency can invite other Federal agencies, Tribes, or State or local agencies which have jurisdiction by law or special expertise to participate as a cooperating agency in the NEPA process. The benefits of cooperating agency participation include disclosure of relevant information early in the process; receipt of technical expertise and staff support; avoidance of duplicative reviews by Tribal, State, and local entities; and establishment of a mechanism for addressing inter- and intra-governmental issues and enhancing inter- and intra-agency and governmental trust. While cooperating agencies are more commonly utilized during the preparation of an EIS, they can be invited to be involved in an EA as well.

For the Bourne and Sagamore Bridges MRER Phase I project, five agencies were invited to participate as cooperating agencies: MassDOT, FHWA, U.S. Coast Guard, EPA, and National Marine Fisheries Service, and all agencies accepted.

Representatives from the following Federal, state, and local agencies, and federally-recognized tribes with interest or jurisdiction in the proposed project were invited to a scoping meeting and coordinated site visit on March 19, 2019. Fifteen members attended (sign in sheets are included in Appendix E).

Federal	U.S. Fish and Wildlife Service U.S. Environmental Protection Agency U.S. National Marine Fisheries Service (NOAA Fisheries) U.S. Coast Guard Federal Highway Administration
State	Massachusetts Department of Transportation Massachusetts Office of Coastal Zone Management Massachusetts Department of Environmental Protection Massachusetts Department of Fish and Game o Massachusetts Division of Marine Fisheries o Massachusetts Division of Fisheries and Wildlife - Massachusetts Natural Heritage and Endangered Species Program Massachusetts Historic Preservation Office
Tribal	Wampanoag Tribe of Gay Head (Aquinnah) Wampanoag Tribe of Mashpee
Regional	Cape Cod Commission
Local	Bourne Conservation Commission Sandwich Conservation Commission Sandwich Historic Commission

Early coordination was also conducted with several resource agencies including: U.S. Fish and Wildlife Service, National Marine Fisheries Services, MA Office of Coastal Zone Management, and MA Historic Preservation Office to discuss project plan formulation and consider potential impacts to specific resources and agency comments and concerns. Further consultations will continue during Phase II of the project with these and additional agencies and interests. A complete list on compliance with environmental Federal Statues and Executive Orders is included in the EA.

10.0 CULTURAL RESOURCE CONSIDERATIONS AND ANALYSIS

In the study area, there are three historic period resources, the Bourne and Sagamore bridges, and the canal. There are no identified archaeological resources in the vicinity of the Sagamore Bridge study area. There are two archaeological sites within the vicinity of the Bourne Bridge, pre-contact site 19 BN-224, and post-contact archaeological site, BOU.1. The study area could have archaeological sensitivity. Many pre-contact and post-contact sites have been identified in the study area, and more are likely still unidentified.

10.1 General Cultural Resource Concerns

The National Historic Preservation Act (NHPA) (1966) defines a historic property as any prehistoric or historic districts, sites, buildings, structures, or objects that are eligible for, or listed on the National Register of Historic Places. Section 106 of the NHPA requires that a federal agency take into account the effects of an undertaking on historic properties.

The earliest pre-contact sites from the PaleoIndian Period (12,000 – 10,000 B.P.) have not been positively identified on Cape Cod. Evidence of *in situ* Early Archaic Period (10,000 – 7,500 B.P.) sites are also relatively rare as the environmental landscapes continued to change and the sea levels continued to rise. Sites from the Middle Archaic Period (7,500 – 5,000 B.P.) to the Contact Period (1500 – 1650 A.D.) are much more apparent in the pre-contact record.

Cape Cod was one of the first areas to be explored and settled by Europeans and as a result contemporary accounts record Native American settlements as well as interactions with European traders, explorers and settlers. The importance of trade prompted the building of the Aptuxcet Trading Post in Bourne in 1627.

10.2 Cultural Resource Impacts

Under the Base Condition (Plan A) there will be no effect on historic properties. The bridges would continue to be maintained and repaired and there would be no effect on local historic districts, individual buildings, or known and unknown archaeological sites, since there would be no change in bridge appearance or location.

With Major Rehabilitation (Plan B) the rehabilitation of the Bourne and Sagamore bridges should have no adverse effect to the bridges and no effect on local historic districts, individual buildings or known and unknown archaeological sites. There would be no changes in bridge appearance or location.

Under Bridge Replacement (Plan D) there would be an adverse effect on the existing bridges (they would be removed) and on at least two identified archaeological sites, possible unidentified archaeological resources, and several historic districts. The effects would be indirect (visual and/or viewshed) as well as direct (possible archaeological sites).

10.3 Cultural Resource Coordination

Cultural resources coordination was initiated on the Canal highway bridges with the State Historic Preservation Officer (SHPO), Tribal Historic Preservation Officers (THPOs) of the Mashpee Wampanoag and the Wampanoag Tribe of Gay Head (Aquinnah), and the Historic Commissions of the Towns of Bourne and Sandwich. Each of these were invited to the December 2018 public information meetings. Coordination letters were sent to the State and Tribes on July 17, 2019.

Additional consultation with the SHPO, THPOs of the Mashpee Wampanoag and the Wampanoag Tribe of Gay Head (Aquinnah), and local historical commissions on the location of the bridges and the bridge design would be required during Phase II of the project.

10.4 Cultural Resource Recommendations

Additional surveys of known and potential archaeological sites, as well as the impact area in general, would be required during Phase II. This work should be scoped with input from State, Tribal and local historic preservation officials and commissions.

The fate of the existing bridges is expected to be a matter of some concern. The bridges have served their purpose for 85 years and have become somewhat of an icon for residents of Southeastern Massachusetts and visitors to the Cape and Islands. Demolition of the bridges, and potentially design of new bridges of a different type, may generate some level of opposition, despite their reliability problems.

11.0 OTHER SOCIAL EFFECTS CONSIDERATIONS AND ANALYSIS

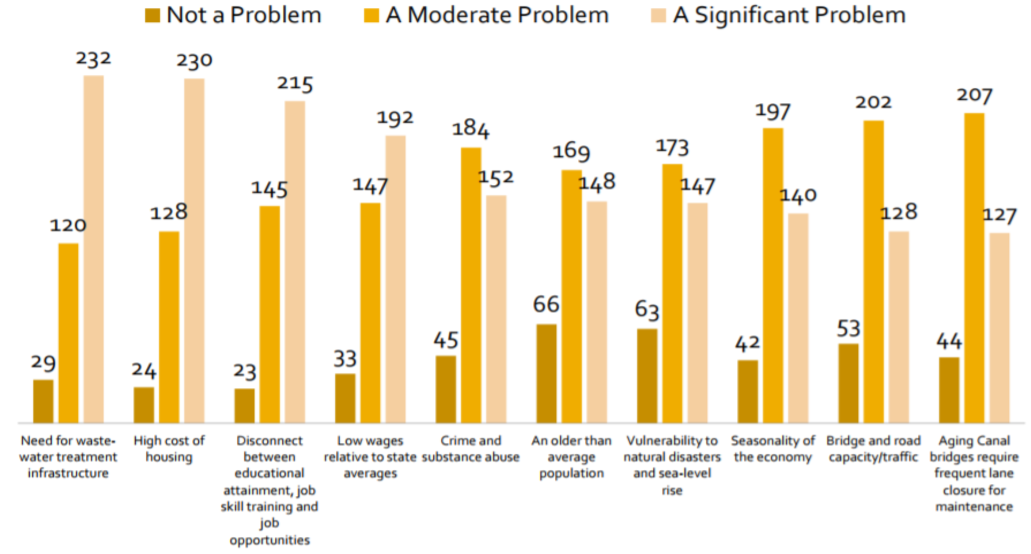
This chapter identifies potential other social effects from the four plans under detailed analysis

11.1 Background and Purpose

The Bourne and Sagamore Bridges were opened in 1935. Given their age and exposure to the elements, they frequently require major repairs. Issues surrounding the bridges are important to residents of the area. Results from the 2014 Comprehensive Economic Development Strategy (CEDS) Stakeholder Survey of 397 Cape Cod residents demonstrate that more than 83% of respondents find existing bridge and road capacity, and frequent interruptions from bridge maintenance to be a problem (see Figure 21).

Figure 21 - CEDS Stakeholder Survey (Cape Cod Commission 2014)

How much of a problem do you feel the following challenges are to the long-term economic success of the region?



The USACE "Other Social Effects Handbook" outlines the following social factors that should be considered in OSE analysis: health and safety, economic vitality, social connectedness, identity, social vulnerability and resiliency, participation, and leisure and recreation. Including OSE information in the planning process is essential to gain a deeper understanding of the issues and population affected by a proposed project, and to improve communication among all affected parties[21].

11.2 Community Characteristics

11.2.1 Population Size and Composition

The current year-round populations of the Cape and Islands (Barnstable, Dukes and Nantucket Counties), and the town of Bourne are displayed in Table 37. The population of the Cape and Islands grew over 130% between 1970 and 2000. Since 2000, population growth tapered in Dukes and Nantucket Counties, and slightly decreased in Barnstable County. According to the Cape Cod Commission these population dynamics are largely attributed to a large influx of baby boomers retiring to the region, the subsequent increase in death rates due to an ageing population, and younger populations leaving the region to pursue employment and educational opportunities. Various studies in recent years have predicted both declines and increases in Barnstable County's population over the next one to two decades.

Table 37 - Total Population – Cape Cod and Islands

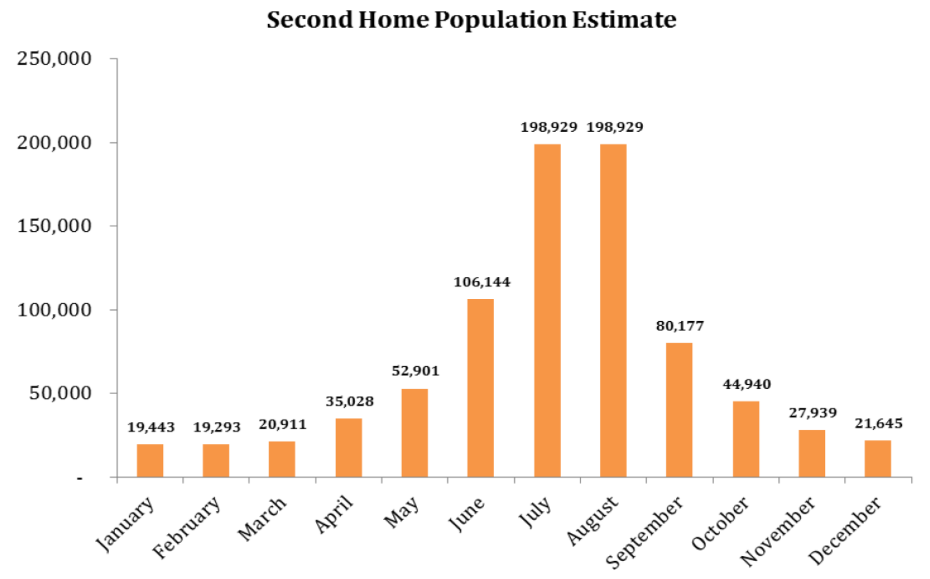
	Total Population 2000 Census	Total Population 2010 Census	Total Population 2015 ACS
Bourne	18,721	19,754	19,729
Barnstable County	222,230	215,888	214,766
Dukes County	14,987	16,535	17,048
Nantucket County	9,520	10,172	10,556
Massachusetts	6,349,097	6,547,629	6,705,586

Source: 2010 United States Census, 2015 American Community Survey

Seasonal Population: The populations of Cape Cod and the Islands experience dramatic seasonal shifts. Many individuals have second homes on the Cape or Islands, and many are used as vacation rental properties during the summer season. The Cape Cod Commission estimated monthly populations in Barnstable County based on second home ownership, and show that the summer population can be ten times the winter population (Figure 22). Similar estimates by the Martha's Vineyard Commission report the Dukes County summer population to be five times the year-round population. Because these estimates of monthly population only consider visitors who own or rent a property, and does not take into account individuals doing day trips, they likely underestimate the actual population on a summer day. The proportion of houses that are used for seasonal, recreational, or occasional use is at least eight times the state average across the three counties (Table 38).

Future Population: Approximately eight percent of survey respondents indicated they plan to convert their second home into their primary home in the next five years; an additional 14% plan to convert their home in the next 15 years. Moody's analytics projects that economic growth in the area will stimulate in-migration resulting in an increase of 9,612 people to Barnstable County between 2015 and 2025; Crane Associates similarly projects a more conservative increase in population of 6,199 people. Increases in the year-round population will consequently increase demands on local services and infrastructure, including the bridges.

Figure 22 – Barnstable County Summer Population



Source: Daley 2015. Second home population estimates are based on UMass Donahue Institute's Second Home Owner Survey 2008 and the 2010 U.S. Census

Table 38 - Proportion of Seasonal-Use Houses

	Percentage of houses for seasonal, recreational, or occasional use
Bourne	20.6%
Barnstable County	35.5%
Dukes County	53.8%
Nantucket County	57.9%
Massachusetts	4.1%

Source: 2010 U.S. Census

11.2.2 Population Structure and Diversity

Age Distribution: The population increase between 1970 and 2000 was driven by people retiring to the Cape and Islands[8]. As a result, the median age in Barnstable and Dukes Counties is 30 and 17% higher than the state-wide median age (Table 39). Likewise, the percent of the population 65 and older is substantially higher, and the proportion of individuals 15 and under substantially lower, in Barnstable and Dukes Counties compared with Massachusetts as a whole.

Table 39 – Age and Ethnicity – Cape Cod and Islands

	Median age	Percent 65 and older	Percent 15 and under	Percent foreign born population	Percent white, non-hispanic
Bourne	46.25	21.2%	14.8%	3.8%	91.3%
Barnstable County	51.3	27.1%	14.1%	6.8%	91.1%
Dukes County	45.9	19.0%	16.6%	9.7%	92.1%
Nantucket County	39.5	13.4%	19.4%	16.3%	76.6%
Massachusetts	39.3	14.7%	18.3%	15.5%	74.3%

Racial Composition: With a population that is more than 90 percent Caucasian, the racial makeup of Barnstable and Dukes Counties is homogenous compared with the rest of the state (74.3% Caucasian) (Table 38). Nantucket County's non-white population is similar to that found across the state of Massachusetts.

11.2.3 Employment and Industry

The Cape and Islands' economies rely heavily on summer tourism, and are thus seasonal. The number of employed individuals increases by nearly 20% during the summer months in Barnstable County, 50% in Dukes County and 70% in Nantucket County. In addition, because there are relatively fewer employment opportunities on the Cape and Islands compared with areas closer to the Boston metropolitan area, MassDOT estimates that at least 13,000 Cape Cod residents commute over the Bourne and Sagamore Bridges daily to work on the mainland[36].

Barnstable County's labor participation rate is 7% lower than Massachusetts overall, and the percent of households with retirement income in Barnstable county is more than 50% higher than Massachusetts overall. Barnstable County's lower labor force participation and greater proportion of households with retirement income is not surprising given many individuals relocate to Cape Cod in their retirement. Labor force participation in Nantucket County is greater than state-wide estimates. Dukes County's labor force participation is similar to that of the whole state (Table 40).

Table 40 – Employment Proportions by Industry – Cape and Islands					
Industry	Town of Bourne	Barnstable County	Dukes County	Nantucket County	Massachusetts
Agriculture, Forestry, Fishing, Hunting, and Mining	0.3%	0.9%	2.4%	2.3%	0.4%
Construction	9.5%	9.4%	15.2%	17.4%	5.4%
Manufacturing	4.7%	3.7%	4.1%	3.4%	9.2%
Wholesale Trade	2.6%	2.0%	1.6%	1.7%	2.4%
Retail Trade	13.1%	14.0%	9.8%	14.0%	10.8%
Transportation, Warehousing, & Utilities	5.1%	4.1%	2.2%	4.6%	3.6%
Information	2.5%	1.9%	2.0%	2.3%	2.3%
Finance and Insurance, Real Estate, Rental and Leasing	7.0%	6.5%	9.1%	7.2%	7.6%
Educational, Health Care, and Social Services	25.2%	24.1%	18.6%	16.3%	27.9%
Arts, Entertainment, Recreation, Accommodation, and Food Services	9.9%	11.7%	12.8%	10.7%	8.8%
Other Services Except Public Administration	3.4%	4.9%	5.2%	5.0%	4.4%
Public Administration	6.3%	4.8%	4.8%	4.3%	4.0%
Professional, Scientific and Management Services	10.4%	11.9%	12.2%	10.6%	13.2%

11.3 Alternatives: Consequences to Community Characteristics

Plan A – Base Condition (Fix-as-Fails): While there may be no immediate impact on community characteristics, the bridges will continue to deteriorate requiring frequent closures resulting in long delays and disruption to normal activities. This may result in slower population growth, less educational and employment opportunities.

Plan B – Major Rehabilitation: Because the bridges do not comply with current highway standards, each maintenance/repair event requires lane and entire bridge closures causing restriction of each bridge's carrying capacity during each maintenance/repair event.

As described in Section 5.3.1 construction activities will require 376 days of lane closures, and 132 days of full bridge closure on Sagamore Bridge from 2025 to 2027. Similar construction activities will require 481 days of lane closures and 180 days of full bridge closures on the Bourne Bridge between 2029 and 2031. These land and bridge closures will only occur during restricted periods of the year, when there is no seasonal and holiday traffic.

A substantial number of Cape Cod residents commute over the Bourne and Sagamore Bridges daily to work on the mainland, the lane restrictions due to construction and resulting traffic congestion may impact wages and job potential for those commuting residents. Tourism also may suffer due to the congestion. When the rehabilitation is not taking place, conditions will return to normal.

Plans D – Bridge Replacement: During construction of new bridges, it is not expected to have a significant adverse impact on community characteristics. However, at the completion of the new bridges, improved traffic and road conditions will likely attract more visitors, expand educational and employment opportunities, and potentially bring new residents to the Cape and the Islands. Overall, this will positively benefit the community characteristics.

11.4 Baseline OSE Factors and Conditions for Cape Cod and the Islands

11.4.1 Health and Public Safety

This section describes project conditions that change the actual or perceived risk of health and safety. For instance transportation restrictions on the bridges would increase daily commuting time, decreased the ease of travelling between the Cape and mainland, and decrease the ability of residents to evacuate in a hurricane, all with potential impacts to health and safety.

Disaster Response: Bridge rehabilitation will influence disaster response on Cape Cod (the Islands to a lesser extent). Cape Cod is subject to a number of natural hazards. In the 2013 Massachusetts State Hazard Mitigation Plan, Barnstable County received high hazard rankings for flood and coastal hazards, and medium hazard ratings for high wind, hurricane/tropical storms, thunderstorms, and nor'easters.

Disaster response to hurricanes (and other hazards) requires rapid and efficient egress from areas of the Cape. Emergency evacuation of Cape Cod is an important issue due to the high probability of hazardous events, and the high traffic volume and low capacity road conditions that are exacerbated by the bottleneck created by the bridges. As of the 2010 census 40% of Barnstable County's total population was living within the County's Hurricane Evacuation Zone. The Cape Cod Emergency Traffic Plan outlines the travel restrictions that may be imposed during evacuation of the Cape. Such restrictions may include exit closures, detours, and one-way travel on roads and bridges. The bridges may be closed if weather and traffic conditions make it unsafe to cross them, in which case motorists would be directed to Joint Base Cape Cod for shelter.

Emergency Response: The town of Bourne is divided by the Cape Cod Canal with the two sides of town accessed via the bridges. The Bourne police department has one station which is located north of the bridges. The town's fire stations are located on either side of the bridges. The Town of Sandwich has a small portion of its area located on the mainland side of the Sagamore Bridge along the shore of Cape Cod Bay, with most of the town located on the Cape Cod side.

The Bourne Police and Fire Departments were consulted on the difficulties presented by the existing bridges and the potential impacts of bridge maintenance and rehabilitation. The two Departments offered the following information:

- Even without construction, increased congestion on the bridges during the summer results in delayed emergency response.
- Inspection and training schedules need to be adapted to accommodate the traffic delays.
- The Departments are often forced to hire additional staff on overtime to account for delays.
- During summer months, high traffic congestion greatly influences to which hospitals emergency responders are able to transport patients.
- Any lane closure on either bridge, for any amount of time, drastically impacts Emergency response time. Long term closures would have a very negative impact on our ability to operate and respond to calls safely and efficiently.

- Further restricting bridge access through lane or bridge closures will have extreme, adverse effects on emergency services any time of the year.

From the traffic model data used in this study, the increase in summer traffic volume leads to a >75% increase in travel time from the Bourne police station to the south side of the bridges.

Military Installations: Joint Base Cape Cod (JBCC), located in Bourne, Sandwich, Falmouth and Mashpee, is a military installation housing five military commands including the National Guard and Air Force. The two existing highway bridges are the main access points for all JBCC goods and services, however some supplies are transported to the Cape via the rail system. In addition many JBCC personnel live off-Cape and commute to JBCC via the bridges.

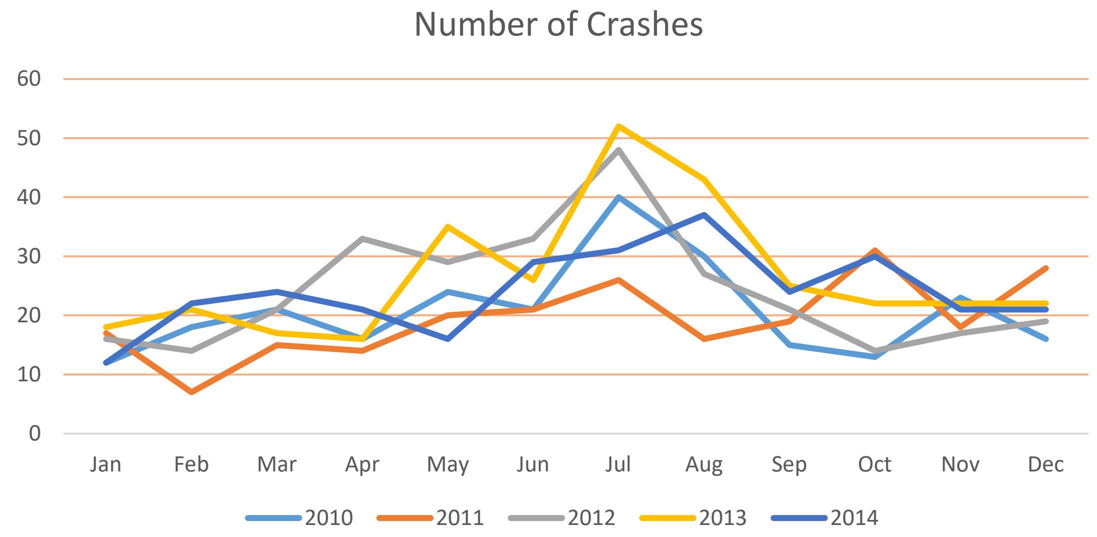
Health Services: Barnstable County's population is ageing, with a greater need for health services, however the availability of health services is less than that of Massachusetts overall. The number of primary care physicians per 10,000 people is nearly 30% lower in Barnstable County compared with Massachusetts. Retirees will often travel off-Cape to see their mainland doctors. There are no VA hospitals in the area, so veterans must travel to Providence or Boston to use VA services.

There are currently no Level I or II trauma centers on Cape Cod, so most trauma patients are transported to Boston hospitals for care. According to Cape Cod Healthcare, about 1500-1600 trauma cases each year are transported off of Cape Cod for treatment, about twice the number treated at local Cape Cod hospitals. Much of this transport occurs via ground transportation over the bridges.

Traffic Incidents: Because the bridges create bottlenecks, traffic incidents are common at the bridges' entrances. The south entrance of the Bourne Bridge and the north entrance of the Sagamore Bridge are among the Cape Cod Commission's Cape-Wide top 10 crash locations list. According to MassDOT, between 2010 and 2014, there were 1380 total crashes within one mile of the two bridges; 333 resulted in non-fatal injuries and seven resulted in fatalities. Unsurprisingly, with a greater number of vehicles on the road, there are more crashes during the summer months (Figure 23).

The sidewalks on the bridges do not meet federal standards because of their narrow width and proximity to moving traffic. Pedestrians must also share the narrow sidewalks with bicycles. Guardrails and other features are not up to current standards. However the narrow lane widths are the greatest safety concern on the bridges.

Figure 23 – Number of Monthly Crashes within One Mile of the Bridges (2010-2014)



http://services.massdot.state.ma.us/crashportal/DataRequest.aspx).

Plan A: There will be little immediate impact to health and public safety from continuing repairs as needed to the two existing bridges. However, as the bridges continue to deteriorate, more frequent and costly repairs will be required to keep them safe and reliable, with adverse impacts to traffic and access by emergency responders. The fix-as-fails alternative is meant to address health and public safety issues by capturing the items necessary to prevent a potential bridge failure. Even with continuing inspection and repair there is uncertainty regarding bridge failure. There is no absolute guarantee that failure will not occur, with the inherent risk to life and public safety. However, with a proper comprehensive program of inspection, repair and maintenance as needed the risk of failure of either bridge is low.

Plan B: The Bourne and Sagamore bridges will undergo lane closures and complete bridge closures during the rehabilitation process, influencing emergency officials' ability to evacuate residents from the Cape during hazardous events. Cited increases in travel time pertain only to the bridge segments, and do not include increased travel time on road segments leading up to the bridges. Travel delays associated with lane and bridge closures would make evacuation of Cape visitors and residents prior to a major storm landfall difficult.

Also, since the bridges are primary access points for JBCC, bridge rehabilitation may have substantial impact on the ability of the units to carry out their training mission. When the rehabilitation is not taking place, conditions will return to normal.

Plans D: Construction of new bridges is not expected to have a significant impact on Health and Public Safety. New bridges would improve road conditions resulting in positive impacts to health and public safety. The improvements which include wider lanes and pedestrian access will allow safer travel. New bridges would not require repair for some time, so the need for lane closures and construction related delays would not occur.

11.5 Economic Vitality

The economic vitality of Cape Cod concerns factors such as employment, educational opportunity, income inequality, and access to markets, all of which influence quality of life. The U.S. Travel Association produced a report estimating the economic impact of travel in Massachusetts in 2015, based on travel more than 50 miles away from home on day or overnight trips (not commuting). Barnstable County is among the top five counties generating the most travel-dollars in Massachusetts. The estimated contribution of domestic and international travel to local, state and federal economies is shown by county in Table 41.

Table 41 – Travel Impact – 2015 (U.S. Travel Association 2016)

State estimates are provided in the U.S. Travel Association's report (2016). The ratio of domestic county-level and state-level travel impacts were used to estimate international travel impact at the County-level.

Cost in $ Millions	Travel Expenditures	Travel-Generated Payroll	Employment (Thousands)	Federal Tax*	State Tax	Local Tax
Domestic Travel Impacts – 2015						
Barnstable County	1,006	260	9	92	44	61
Dukes County	141	35	1.3	12	5.5	8.2
Nantucket County	168	36	1.1	11	5.3	6
Massachusetts	17,485	3,805	116	1464	700	439
International Travel Impacts – 2015						
Barnstable County	158	42	1.5	16.7	7.0	8.1
Dukes County	22	5.6	0.2	2.1	0.9	1.1
Nantucket County	26	5.8	0.2	2.0	0.8	0.8
Massachusetts	2,749	609	19	265	112	58

*County-level Federal Tax is estimated as a proportion of state tax

Tourist dollars are important for the local economy on the Cape and Islands. There were over one billion dollars in direct expenditures from visitors to the area in 2015. Tourism on the Cape and Islands generated over 100 million federal tax dollars, and over 100 million state and local tax dollars. In addition, more than 10,000 jobs were supported by the tourism industry, generating over 300 million dollars in wages.

Small businesses are prevalent on the Cape and Islands. Cape business owners face an issue with employee recruitment and retention. Because housing is more expensive on Cape Cod, individuals choose to live off-Cape in adjacent communities, and commute to the Cape for work. However, increasing traffic congestion and commute times, coupled with relatively low wage rates on the Cape, is resulting in employees seeking opportunities off of the Cape.

Barnstable County's Gross Regional Product in 2015 was $9.8 billion, with retail and construction among the top industries. Nearly 100% of construction materials and goods sold are transported to the Cape and Islands from the mainland. In addition, goods produced on the Cape and Islands, such as seafood, are generally shipped to or beyond the mainland. Increasing traffic congestion due to increased population and visitors makes it more difficult to deliver goods to and from the Cape and Islands.

Nearly all goods, including groceries, medical supplies, and construction materials are transported to the Cape and Islands via trucks. MassDOT estimates 6,600 trucks traverse the bridges each day. Trucks traveling to and from the Islands via the Woods Hole, Martha's Vineyard and Nantucket Steamship Authority (a state-chartered authority) traverse the Canal bridges to transport goods via ferry access from Hyannis or Woods Hole. The Steamship Authority reports that in 2015 more than 62,000 trucks traveled round-trip between Woods Hole and Martha's Vineyard, and over 23,000 trucks traveled round-trip between Hyannis and Nantucket. The Cape Cod Commission reports that the canal bridges are the primary bottleneck for truck freight in the region and that many freight companies will not locate on Cape Cod because of traffic delays at the bridges.

Passenger bus services regularly cross the bridges to bring residents and visitors to/from the Cape and Islands. Weekday summer ridership of the Plymouth & Brockton Bus Line, for instance, exceeds 1,200 daily riders over the bridges. During May and October, nearly 1000 riders cross the bridges by bus. Weekday ridership, particularly during the off-peak season, is presumably residents traveling to/from work off on the mainland.

Plan A: While there may be no immediate impact on economic vitality, the bridges will continue to deteriorate requiring frequent closures resulting in long delays and disruption to normal activities. This may result in less tourism to the area, impacting small business and the economics.

Plan B: The lane and bridge restrictions due to rehabilition construction and resulting traffic congestion will impact tourism and the important economic benefits. The annual $1 billion in tourist dollars is critical to the local economy on the Cape and Islands. The large volume of truck traffic (>6,600 trucks anually) supplying the Cape with goods (including groceries, medical supplies and construction materials) would be severely impacted by lane and bridge closures. When the rehabilitation is not taking place, conditions will return to normal.

Plan D: Construction of new bridges is not expected to have a significant impact on economic vitality except for increased construction work near the bridges. The completion of the new bridges will improve traffic and road conditions will likely attract more visitors and allow more commerce to traverse the bridges. This will potentially expand the economy, bringing more prosperity to the region.

11.6 Social Connectedness

The current state of the bridges has a negative impact on social connectedness of Cape and Islands communities. Communication and relations within and among groups provide a sense of social connectedness and trust. For residents who live near the bridges, the bottleneck effect creates so much traffic in the summer that local residents feel trapped in their houses. The narrow bridge sidewalks do not meet Federal Standards, and are difficult for pedestrians to use because of bicycle use and their proximity to moving vehicular traffic.

The main access points to Martha's Vineyard and Nantucket are on Cape Cod, therefore residents and visitors to the Islands must cross the bridges to travel to and from the Islands. In 2015, approximately 240,000 automobiles and nearly 1,200,000 passengers traveled round-trip between Woods Hole and Martha's Vineyard. Approximately 42,000 automobiles and over 320,000 passengers traveled round-trip between Hyannis and Nantucket (Table 42). MassDOT's traffic data suggest that travel to and from the Islands generates 2,700 vehicle trips daily over the bridges during the summer.

Table 42 – Steamship Authority Ridership 2015 (Steamship Authority 2016)

	Between Woods Hole and Martha's Vineyard	Between Hyannis and Nantucket	Total
Passengers	2,378,303	644,787	3,023,090
Vehicles under 20 Feet in length	475,286	84,215	559,501
Vehicles over 20 Feet in length	49,069	29,588	78,657

Plan A: The current state of the bridges has a negative impact on social connectedness of Cape and Islands communities. Traffic delays and lane closures back up traffic on the approach highways and local roadways. Residents living near the bridges feel "trapped" in their houses in the summer. Bridge sidewalks are difficult to use. Continued maintenance and repair of the existing bridges will not ease any of these situations.

Plan B: Rehabilitation of the bridges will require frequent lane and bridge closures resulting in substantial and prolonged disruption to social connectedness. The current bottleneck at the bridges isolates the surrounding neighborhoods and would worsen with the traffic delays caused by rehabilitation actions. Pedestrian and bicycle traffic will continue to be constrained. When the rehabilitation is not taking place, conditions will return to the current level of delay and congestion.

Plans D: Construction of new bridges is not expected to have a significant impact on social connectedness. The completion of the new bridges will improve traffic and road conditions resulting in more social connectedness among the residents. The improvements which include wider lanes and better pedestrian access will allow safer and less stressed travel. The new bridges would not require near term repairs, so the need for lane closures and construction related delays would be far less than with the other alternatives.

11.7 Identity

It is important to consider how project activities may influence individuals' and groups' language, tradition and values, thereby influencing their sense of identity. While the Cape and Islands are a tourist destination, the area is dominated by the second home market, rather than hotels and motels. Many of these second homes have been passed down through several generations, and either rented to tourists and/or used as a family vacation home during the summer season. The historic villages, with their small, quaint shops, also contribute to the unique character of the Cape and Islands.

While current levels of traffic are a concern for Cape residents, many fear that improving transportation infrastructure would encourage more commercial development, threatening the Cape's environmental quality and historic charm. Traffic throughout the Cape is difficult in the summer as visitors tax the road system's capacity.

Plan A: While there may be no immediate impact on the unique character of the Cape and Islands, the bridges will continue to deteriorate requiring frequent closures resulting in long delays and disruption to tourism and normal activities.

Plan B: Rehabilitation of the bridges will require frequent lane and bridge closures resulting in substantial and prolonged disruption to traffic heading to the Cape and Islands. Major rehabilitation of both bridges would extend the life of the structures and reduce maintenance and repair for a period of time until deterioration of the bridges began to once again require frequent repairs with its consequences to travelers and the local population. Disruptions to the communities and their impacts on the identity within the community would then resume.

Plans D: Construction of new bridges is not expected to have a significant impact on identity. The completion of the new bridges will improve traffic and road conditions allowing residents and tourists to travel more easily to the quaint villages of Cape Cod and the Islands. The improvements which include wider lanes and pedestrian access will allow safer and less stressed travel. The new bridges would not require repair for some time, so the need for lane closures and construction related delays would not occur. It should be noted the existing internal Cape road system may not be able to handle additional traffic capacity.

The reduced closures, wider lanes, and provision of auxiliary lanes would make traffic safer and move traffic faster over the new bridges. With the new bridges the two through traffic lanes would equal the two through lanes provided by state highway approaches on either side of each bridge. Expansion of state highway capacity would be needed to appreciably increase traffic volume over the bridges. While the state plans improvements to modify the approaches to match the new bridges, and ease traffic entering and existing the highways in the vicinity of the bridges, no increases in highway capacity are planned.

11.8 Social Vulnerability and Resiliency

Some groups are more socially vulnerable and less resilient than others. For instance, elderly individuals may be disproportionately affected by transportation interruptions because they may need to seek more specialized services off of the Cape and Islands, and may face more mobility issues than younger populations.

The factors contributing most to variation in socially vulnerability across the state are race/ethnicity, wealth, and age. Barnstable County substantially differs from the state due to the age of its population, and also has lower-than-average income levels.

Plan A: While there may be no immediate impact on the social vulnerability and resiliency of the population, the bridges will continue to deteriorate requiring frequent closures resulting in long delays and disruption travel across the bridges.

Plan B: Rehabilitation of the bridges will require frequent lane and bridge closures resulting in substantial and prolonged disruption to traffic heading to the Cape and Islands. Some groups are more vulnerable and less resilient than others, including elderly residents that may be negatively impacted by the challenges of rehabilitation and subsequent delays on the bridges. When the rehabilitation is not taking place, conditions will return to the existing condition.

Plans D: Construction of the new bridges is not expected to have a significant impact on social vulnerability and resiliency. The completion of the new bridges will improve traffic and road conditions allowing residents and tourists to travel more easily across the bridges. This will result in more resilient populations and improvement of lifestyle and lessen the vulnerability that stems from traffic disruptions.

11.9 Participation

Participation is an individuals' engagement with their community and the decision-making that affects their community. There are several community groups on the Cape and Islands that play an important role in Cape and Islands' policies and programs. Each of the counties has its own Chamber of Commerce, and countless organizations dedicated to special interests such as health care and conservation. The Cape Cod Commission is the leading community group in Barnstable County. It is part of the Barnstable County regional government and responsible for regulation, land use planning, and economic development across the county.

Because the bridges are in poor condition, they require frequent maintenance. The USACE has historically provided the public with ample notice of closures so that travelers can accommodate travel delays associated with lane closures. Engaging them in associated public processes is essential for continued public trust. When possible, maintenance is conducted outside of peak season, daytime lane reductions are avoided and construction is limited to one bridge at a time.

Plan A: While there may be no immediate impact on the participation of the population, the bridges will continue to deteriorate requiring frequent closures resulting in long delays and disruption travel across the bridges. The requirement for frequent notices of closures will continue.

Plan B: Rehabilitation would result in excessive delays to traffic from bridge and lane closures. Communities of the Cape and Islands and the mainland areas would be notified of upcoming maintenance in a timely manner. When the rehabilitation is not taking place, conditions will return to normal.

A potential concern is that communities that are more distant from the bridges are still affected by bridge maintenance, but are often not adequately represented. Public meetings surrounding bridge work could be better advertised to residents from Down Cape (towards Provincetown), or residents of Martha's Vineyard and Nantucket. These residents would be subject to effects of bridge rehabilitation and should have the opportunity to participate in the public process.

Plans D: Construction of the new bridges is not expected to have a significant impact on participation of the population. The completion of the new bridges will not impact the existing condition, and at completion will provide safer and better access. There will be less requirements for public notice of construction lane and bridge closures. This will result in more positive participation not just with the surrounding towns, but with the communities that are more distant from the bridges.

11.10 Leisure and Recreation

Leisure time and recreational opportunities influence individuals' well-being. Project activities and outcomes that influence the availability or accessibility of leisure time and recreational opportunities thus need to be considered.

Being a major tourist destination, recreational activities abound on the Cape and Islands. The area hosts some of the country's finest beaches, walking and biking trails including Cape Cod National Seashore, which had more than 4.72 million visitors in 2016. Shopping, water sports, fishing, boating and golf are major leisure activities, as are dining out and live entertainment. Retail; arts, entertainment and recreation; and accommodation and food services are among the most important industries in Barnstable, Dukes and Nantucket Counties.

Plan A: While there may be no immediate impact on the leisure and recreation activities of the population, the bridges will continue to deteriorate requiring frequent closures resulting in long delays and disruption travel across the bridges.

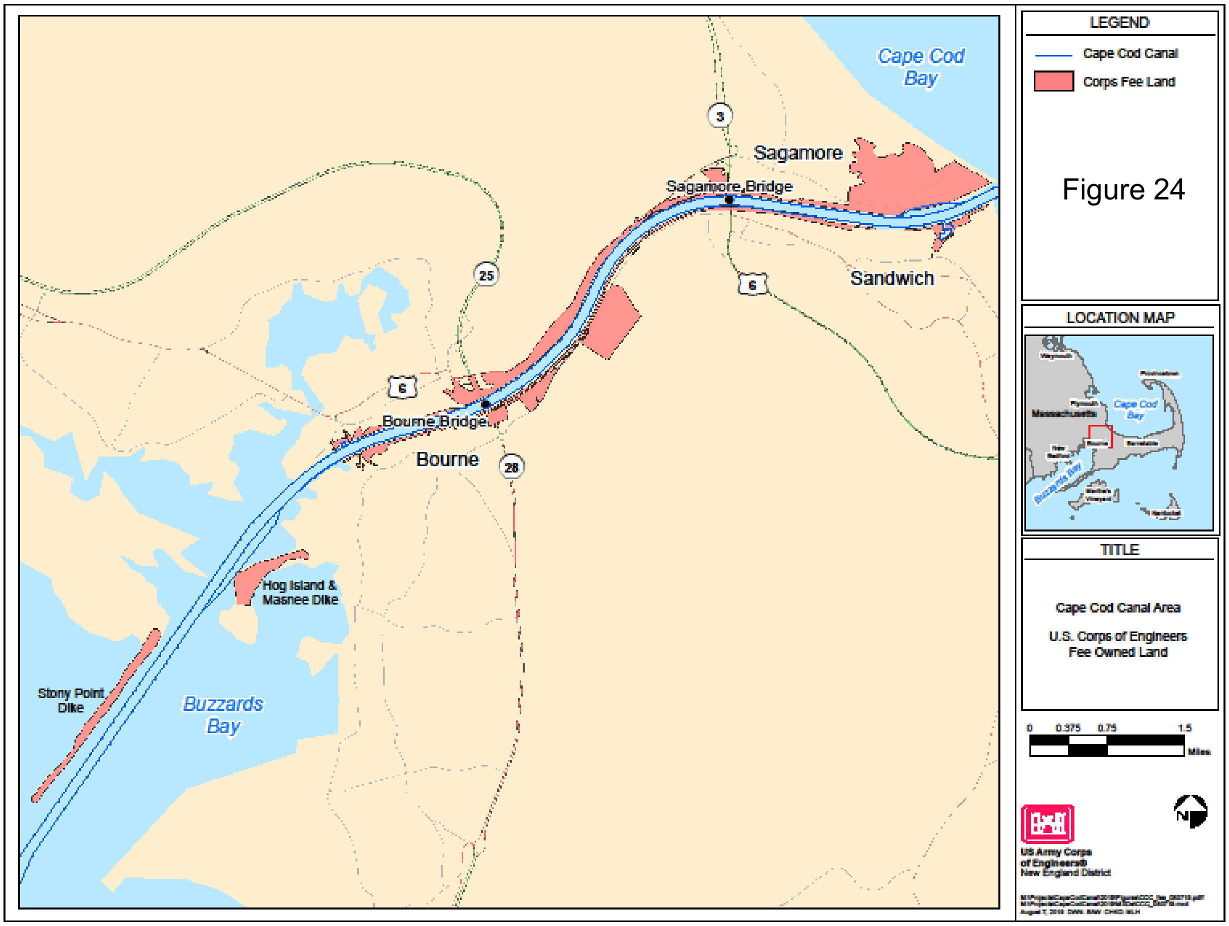
Plan B: Because the bridges are in poor condition, they require frequent maintenance. A program of major rehabilitation would require frequent lane closures and occasional protracted bridge closures. The resulting construction delays will negatively impact leisure and recreation. When rehabilitation is completed the bridges would return to a regular cycle of maintenance and repair. The frequency and duration of repair related impacts would lessen for a period post-rehabilitation and become more frequent as the bridges begin to deteriorate once again.

Plans D: Construction of the new bridges is not expected to have a significant impact on leisure and recreation. The completion of the new bridges will provide safer and better access resulting in more enjoyable leisure and recreational activities on and off the bridges, the surrounding communities and further into the Cape and the Islands.

12.0 REAL ESTATE CONSIDERATIONS AND ANALYSIS

12.1 Existing Federal Lands and Interests

The Cape Cod Canal FNP includes the waterway, lands adjacent to the Canal, its approach channels and dikes, lands used for operations and maintenance facilities, roadways, recreation areas, lands surrounding the East Boat Basin small boat harbor, and the areas occupied by the bridges between and including their abutments. Figure 24 shows the extent of Federal lands for the Cape Cod Canal FNP.



12.2 Land Use and Potential Impacts

Lands abutting the Federal lands around the Canal include a wide mix of zoning and uses. Residential, commercial and public lands surround the Canal. Municipal and State highways cross Canal Federal lands and connect to the bridges. A railroad crosses the west end of the Canal land cut at Bourne, with the line extending along the Cape side of the Canal to Sandwich and then east to Hyannis and Yarmouth. Most of the non-Federal property in the vicinity of the highway bridges is commercial or institutional use. The commercial properties are mainly retail.

12.3 Lands, Easements and Rights of Way Required

For the Base Condition (Fix-as-Fails – Plan A) and the major rehabilitation alternative for each bridge (Plan B) all Federal work would occur on existing Federal lands. Past major rehabilitation efforts for the highway and railroad bridges have used existing Canal property for construction staging, temporary construction facilities, equipment, and other requirements. No additional LERR would be needed for these two plans.

The bridge replacement alternative (Plan D) would require acquisition of new lands to be occupied by the new bridges. Any new bridges would most likely be built close to the existing bridges to minimize the work needed to align them with connecting roadways and reduce the extent of property needed. For the purposes of this report a conceptual plan involving new bridges located adjacent to and immediately inshore of the existing bridges was developed. With both of these bridge alignments the lands needed on the mainland side are currently unimproved and mainly in public hands. The area of impact used for this Phase I evaluation for the two bridges, and the extent of FNP lands in their vicinity, is shown in Figures 25 and 26.

On the Cape side of each bridge acquisition in fee of commercial properties would be needed with regardless of which conceptual alignments were ultimately adopted. For the inshore alignments portions of the Market Basket retail plaza at the Sagamore Bridge, and portions of the Dunkin Donuts property at the Bourne Bridge would need to be acquired, and portions of those uses relocated. If the new bridges were located on the opposite sides of the existing bridges, other commercial and some residential properties would need to be acquired.

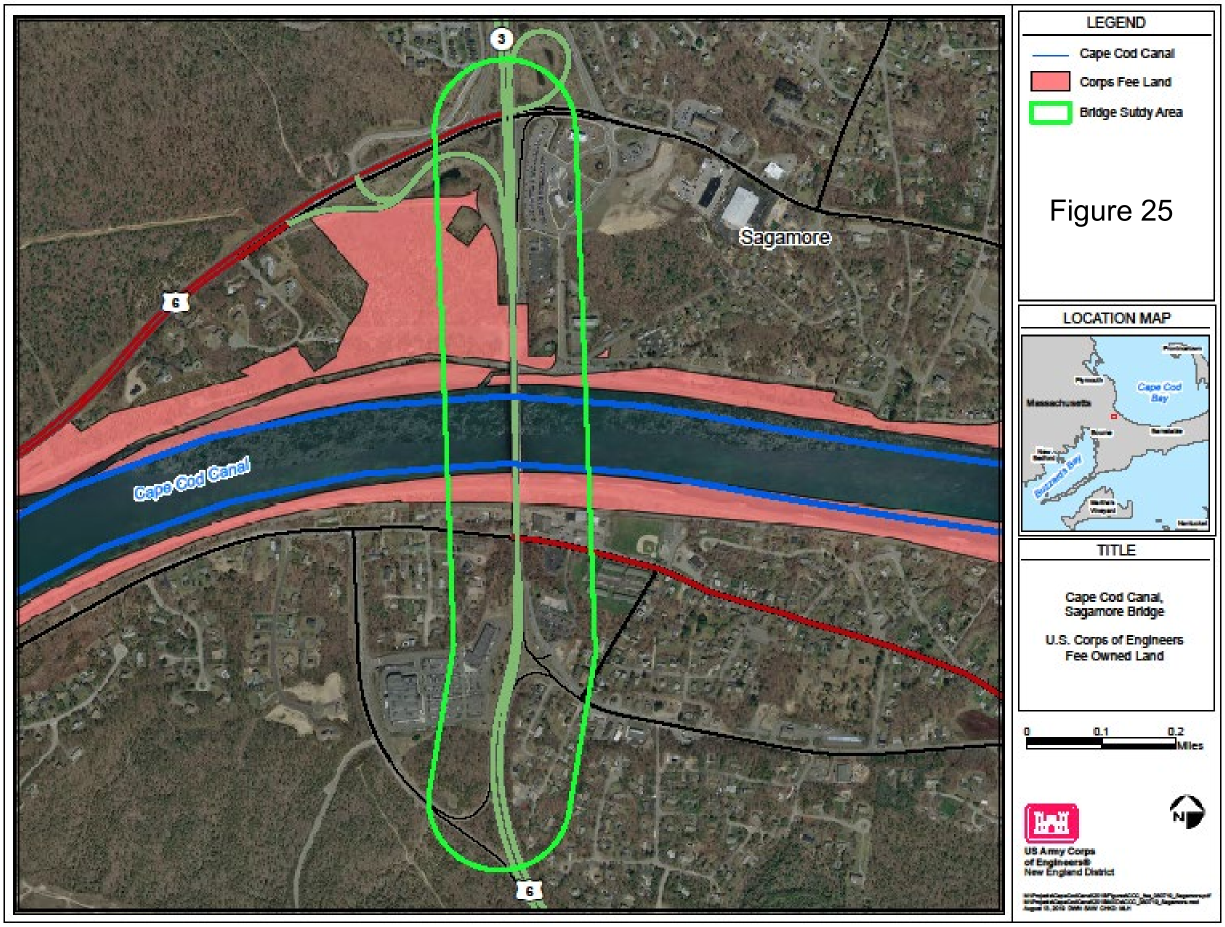
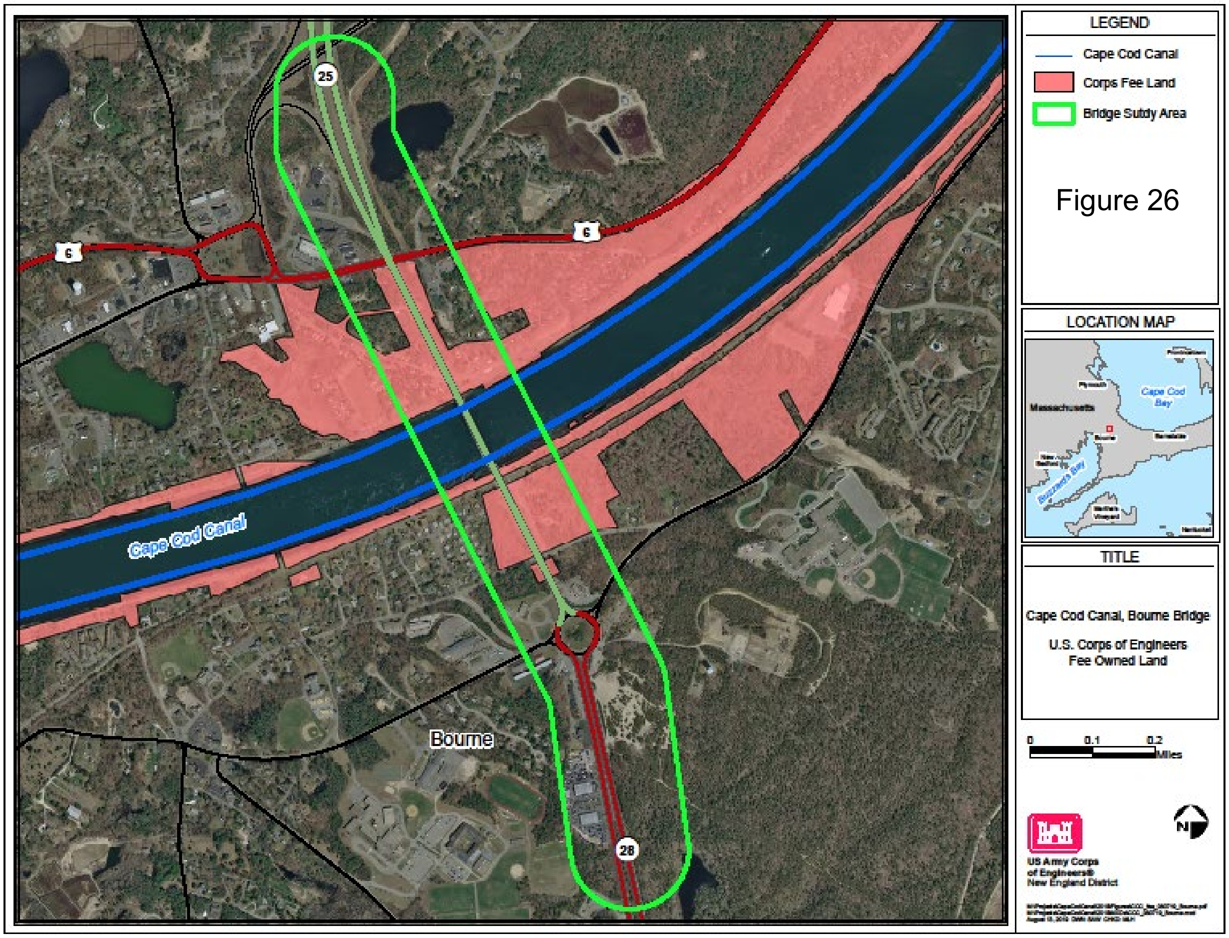


Figure 25

There is a very low risk that the new bridges would be located other than immediately adjacent to the existing bridges. The cost of state connecting road modifications and the extent of real estate acquisition increase with alignment distances further away from the existing bridges. The increasing land area required for ever more distantly spaced structures would have other adverse consequences; impacts to wetlands and other natural resources, sociological impacts from displacement of homes and businesses, and needing different construction areas for old bridge demolition.



12.4 Utility Relocations

A number of utilities cross the Canal over the bridges under license agreements between the utility owner and the USACE. These include electric power lines, telecommunications lines, and natural gas lines. Utility relocations would be required for both the major rehabilitation and replacement alternatives. A list of the utilities requiring relocation is provided in Table 43.

Some of these utilities do not cross the Canal itself but cross Federal property along the Canal. During the next phase a detailed survey of all utilities that may be impacted by the recommended alternative will be made. The extent of impacts and estimates for specific relocation of utilities by the owners will be made during the next phase.

Under the major rehabilitation alternative for each bridge the deck and floor beam replacements will require removal and temporary relocation of the power and telecommunications lines which would be reset following the rehabilitation of those bridge components. The natural gas lines would be removed and relocated off the rehabilitated bridges and would likely require directional drill crossings beneath the Canal.

Table 43 - Utility Licenses Over or Near Bridges

Owner	Utility Type	Description
Bourne Bridge		
Canal Sportsman Club	Water	Supply Line in New Footprint
Colonial Gas	Gas	Pipeline on Bridge
Comcast	Telecommunications	Fiber-Optic Cables on Bridge
Verizon	Telecommunications	Cables on Bridge
Algonquin Gas	Gas	Gas Metering Station
Town of Bourne	Water	Supply Line on Bridge
NSTAR	Electricity	Transmission Line on Bridge
Mass DOT	Drainage	Pipeline in Footprint
Sagamore Bridge		
Open Cape	Telecommunications Sub-license from Verizon	Innerduct for fiber optic cable on Sagamore Bridge.
Verizon	Telecommunications	Cables on Bridge
Mass DOT	Drainage	Pipeline in Footprint
Algonquin Gas	Gas	2 Pipelines on Bridge
Algonquin Gas	Gas	Rectifier & Anode Bed
Colonial Gas	Gas	Pipeline on Bridge
Colonial Gas	Electricity	Subsurface Transmission Lines
Comcast	Telecommunications	Fiber-Optic Cables on Bridge
North Sagamore Water District	Water	Pipeline on Bridge
Note: Further outreach with utility owners will be conducted both for lines crossing the bridges and for utility relocation within the bridge footprints		

Under the replacement alternatives for each bridge the power and telecommunications lines would most likely be relocated to the new bridges as new lines, with the existing lines removed as part of the demolition of the old bridges. Gas lines would not likely be permitted to cross the new bridges and would need to be replaced with alternative crossings. The gas lines that cross the Canal would likely be replaced with one or more new directional drill lines beneath the Canal.

Utility costs were generated from a number of sources based on the information available. The gas line on each bridge that would be relocated via directional drilling under the canal in both the replacement and rehabilitation scenarios was estimated parametrically with the assistance of two directional drilling companies who have performed this work in the greater Boston and Cape Cod Canal areas. Under the replacement scenario the gas metering station adjacent to the Bourne Bridge and the rectifier & anode bed adjacent to the Sagamore Bridge would have to be replaced. The construction of these two facilities was estimated parametrically with the assistance of three construction companies who have performed similar work in the greater Boston and Cape Cod Canal areas. It was also assumed some length of gas, water, and draining pipeline on the mainland and Cape sides of both the Bourne and Sagamore Bridges would require relocation due to the construction of replacement bridges. Under the rehabilitation scenario it was assumed all utilities, besides the relocated gas lines, would be temporarily located outside the limits of work on the bridges. The pipeline relocation costs and the temporary relocation costs were estimated parametrically using an assumed total length of pipeline. The same contingency percentage generated for the replacement and rehabilitation alternatives was applied to the utility relocation costs to mitigate the lack of detailed information on all utilities and their exact existing and proposed locations.

12.5 Lands, Easement, Rights-of-Way and Relocation Costs

Acquisition estimates were based on recent sales of similar commercial and institutional properties in the Bourne and surrounding communities. Acquisition includes lands in fee, some with improvements, plus relocation of portions of business use. Relocations include the costs of moving and relocating utilities. LERR cost estimates for the major rehabilitation (Plan B) and bridge replacement (Plan D) alternatives are shown in the table below.

Table 44 – LERR Costs for Plan D

Updated March 2020	**Bourne Bridge**	**Sagamore Bridge**
Real Estate Interests Required for New bridges		
Lands Acquired	11 Acres	4.5 Acres
Cost of Lands	$4,950,000	$2,025,000
Improvements	$1,000,000	$4,500,000
Business Relocations	$1,000,000	$400,000
Subtotal Real Estate	$6,950,000	$6,925,000
Contingency – 10%	$695,000	$693,000
Total Real Estate	$7,645,000	$7,618,000
Utility Relocation Costs for Rehabilitation and Replacement – FY2020		
Utility Relocation Costs for Major Rehabilitation	$12,749,000	$12,749,000
Utility Relocation Costs for Bridge Replacement	$26,640,000	$29,250,000

13.0 ASSESSMENT OF ALTERNATIVES

The objective of the major rehabilitation evaluation study is to demonstrate that, among the alternatives analyzed, the USACE recommended plan most efficiently and effectively meets the long-term requirement for the Federal Government to provide, operate, maintain, repair, rehabilitate, and replace (OMRR&R) crossings of the Cape Cod Canal for vehicles, pedestrians and other surface traffic. Engineering reliability of the structures, when analyzed together with cost and economic benefits will form the basis of the analysis and determine the recommended plan. The alternatives carried forward into detailed analysis at this stage, as defined in Table 5 earlier include:

Plan A – The Base Plan or No Action Plan – This plan consists of continued maintenance and repairs to both existing bridges as needed to maintain safety (fix-as-fails). Maintenance and repair of both bridges continues without any major rehabilitation. Bridge components are repaired or replaced when inspections yield unsatisfactory reliability ratings.

This alternative is synonymous with a "no action plan" or the "without-project condition", and assumes that the two highway bridges will continue to be operated efficiently and with due diligence for vehicular and marine safety. In the event of unsatisfactory performance of a bridge component, it is assumed that emergency funding will be made available to address the deficiency. This scenario portrays a condition where the reliability of the bridges is allowed to fall below the current condition, but that the bridge remains functional. While components would be repaired or replaced as they fail to meet the condition rating for reliability, the bridges will continue to age and repairs can be expected to be more frequent.

Plan B – Major Rehabilitation – This plan was presented in detail in prior sections. This plan consists of implementing a program of repairs and major rehabilitation for both highway bridges to maintain safety and reliability over the 50-year planning horizon and avoid future restrictions on bridge weight postings. All known structural, mechanical, and electrical deficiencies will be addressed and obsolete components replaced for both bridges. More than one major rehabilitation program would be required; one at the beginning and one near the end of the planning horizon.

Plan D – Replacement with Safety Modifications – Replacement of one or both highway bridges with new bridges each having four through-traffic lanes and two auxiliary acceleration/ deceleration lanes, plus a pedestrian/bicycle lanes in accordance with modern highway standards. A full replacement bridge would be built parallel to one or both existing bridges. The addition of auxiliary lanes in each direction of travel. In conformance with current FHWA and MassDOT standards and guidelines for highway and bridge design, would facilitate safe exit and entrance from the connecting surface roads nearest the Canal.

The bridge replacement plan includes retaining the existing bridges in service until the new bridges are opened to traffic with the old bridges then being removed. Implementation of any plan is subject to future appropriations.

13.1 Risk Assumptions and Variables

The most critical assumption made in this major rehabilitation study is that the Federal Government will continue to honor its obligation to continue to provide safe and reliable access over the Cape Cod Canal and safe and reliable navigation passage through the canal. Congress has authorized this through acts to acquire and improve the Canal, and to maintain the bridges as part of the FNP. In conducting this study the following tasks were performed: (i) the deficiencies of the components of the two existing highway bridges (Sagamore and Bourne Bridges) were identified, (ii) their reliability indices were estimated, (iii) impacts to road traffic and marine traffic from component failure were estimated, (iv) the increases in reliability based on each improvement alternative were estimated, (v) economic benefits were estimated, and (vi) costs to repair deficient components or replace the bridges were estimated. All of these tasks provided inputs to the economic evaluation of alternatives. Increases in reliability, with respect to the costs to attain them, in order to continue safe and reliable navigation and highway access, was the ultimate objective of evaluation.

13.2 Reliability Changes with Alternatives

Table 45 below displays improvements in reliability for the major rehabilitation and replacement bridge alternatives in comparison to the base condition. Under Plan B, a second rehabilitation project in years 2065 (Sagamore) and 2069 (Bourne) will improve the reliability of the superstructure and bridge deck, the substructure will continue to deteriorate. Under Plan D, scheduled repairs to maintain the bridges will be performed in 2049 and 2069 on the Sagamore Bridge, and in 2054 and 2074 (the latter not included in the study period) on the Bourne Bridge.

Table 45
Cumulative Reliability Improvements for Detailed Plans
(at 50 Years – Year 2069)

	Plan A Base Condition	Plan B Major Rehabilitation	Plan D Replacement 4 Lanes with 2 Auxiliary Lanes
Sagamore Bridge			
Superstructure	0.0000	0.9730	1.0000
Bridge Deck	0.0012	1.0000	1.0000
Substructure	0.5802	0.5802	0.9952
Bourne Bridge			
Superstructure	0.0000	0.9862	0.9986
Bridge Deck	0.0012	1.0000	0.9984
Substructure	0.5802	0.5802	0.9972

13.3 Opportunity Costs during Repair and Rehabilitation

As stated in Section 8 – Economic Analysis, during the rehabilitation there will be substantial impacts to traffic flows as construction will require lane or bridge closures. Table 46 below summarizes the estimated closures for each major rehabilitation project. Lane and bridge closures will not occur Memorial Day through Columbus Day to avoid impacting the busy tourist travel seasons as well as Patriots Day and Thanksgiving weekends. For logistical purposes, construction will be limited during the winter months as construction is made more difficult under cold winter weather conditions.

The Sagamore and Bourne Bridges are the only means of vehicular transportation on and off Cape Cod, therefore any road closures incur an economic cost to commuters and local businesses that rely heavily on tourism to the region. Value of time costs were associated with each of these closures as described in Appendix D - Economics and summarized in Section 8 of this report. The total economic impact to travelers during the major rehabilitation of the Sagamore Bridge is estimated to be $661 million and $530 million for the Bourne Bridge Rehabilitation project.

Table 46 – Major Rehabilitation Lane and Bridge Closure Durations

Major Rehabilitation Activity	Bourne Bridge	Sagamore Bridge
Lane Closure Durations (Days)	**480**	**380**
Superstructure, Abutment, Deck and Cable Repairs	230	205
Paving and Painting	250	175
Full Bridge Closure Durations (Days)	**180**	**130**
Interior Gusset Plate Replacement	70	95
Floorbeam Replacement	110	35

13.4 Opportunity Costs during Replacement

The replacement bridges will be built next to the existing bridges. Traffic will continue as usual on the existing bridges during the construction and then relocate to the new bridges when construction is complete. Therefore vehicle traffic is not expected to be disrupted under Plan D. Building new bridges will require closing vessel traffic through the Cape Cod Canal for roughly thirty days for each bridge. Vessels will be required to travel around Cape Cod forfeiting the safety and economic gain of canal passage. The cost for the thirty day closure is roughly $168,000 for each bridge (Appendix D, Section 3.1.1).

13.5 Cost of Detailed Plans

Federal costs cited below include design and construction costs, including PED, construction management, real estate interests, and contingencies.

13.5.1 Plan B – Major Rehabilitation

The cost of the major rehabilitation for the Sagamore Bridge is $156,301,000 for the initial construction cost, $33,425,000 for complete painting in 2045 and $110,940,000 for major repairs including the truss deck replacement, floor beam repair, and complete painting in 2065. Operation and maintenance (O&M) costs are expected to be about $411,000 per year. The cost of the major rehabilitation for the Bourne Bridge is $186,171,000 for the initial construction cost, $26,827,000 for complete painting in 2049, and $132,120,000 for major repairs in 2069. The O&M costs are expected to be roughly $295,000 annually. The total 50-year life-cycle cost for rehabilitation of the Sagamore Bridge would be $368,936,000 and for the Bourne Bridge $407,233,000 (Table 17).

13.5.2 Plan D – Replacement Bridges 4 Lanes Plus Auxiliary on/off Lanes

The cost of a replacement Sagamore Bridge with 4 through lanes plus 2 auxiliary on/off lanes is $486,083,000 ($428,281,000 for the bridge and $57,802,000 for the approaches). In addition there are scheduled major repairs in 2049 and 2069 costing $7,906,000 each. Total cost for the Sagamore Bridge replacement is $501,895,000 (Table 21).

The cost of a replacement Bourne Bridge with 4 through lanes plus auxiliary on/off lanes is $721,764,000 ($630,773,000 for the bridge and $90,991,000 for the approaches). Major repairs are scheduled for 2054 for $7,911,000. Total cost for the Sagamore Bridge replacement is $729,675,000 (Table 21). O&M costs are expected to be about $38,000 annually for each replacement bridge (Appendix D, Section 3.1.14).

13.6 Comparison of Alternatives

A cost-benefit analysis was used to compare the alternatives. This analysis is described in further detail in Appendix D – Economics. Tables 47 and 48 below summarize the results.

Table 47 – Sagamore Bridge Summary Benefit-Cost Analysis Results Scenario Simulation Comparison

FY 2020 Price Levels ($000) Mean Results (Updated March 2020)	Annual Life Cycle Cost	Annual Cost of Rehab or Construction	Annual Benefits	Annual Net Benefits	BCR
Plan A - Base Condition	123,900	-	-	-	-
Plan B - Major Rehabilitation	8,800	35,900	115,100	79,200	3.2
Plan D - Replacement Bridge 4 Lanes with Auxiliary Lanes	4,400	17,400	119,500	102,100	6.9

Note: Costs shown above are the results of the Monte Carlo simulations and may not round or add precisely. See Appendix D – Economics, Table D-77.

Table 48 – Bourne Bridge Summary Benefit-Cost Analysis Results Scenario Simulation Comparison

FY 2020 Price Levels ($000) Mean Results	Annual Life Cycle Cost	Annual Cost of Rehab or Construction	Annual Benefits	Annual Net Benefits	BCR
Plan A - Base Condition	65,200	-	-	-	-
Plan B - Major Rehabilitation	6,100	27,100	59,100	32,000	2.2
Plan D - Replacement Bridge 4 Lanes with Auxiliary Lanes	6,900	21,300	58,300	37,000	2.7
Note: Costs shown above are the results of the Monte Carlo simulations and may not round or add precisely. See Appendix D – Economics, Table D-78.					

Based on BCRs and Net Annual Benefits only, the rank of alternatives (with 1 being the most desirable) is:

1. Replacement of Both Bridges –(Plan D)
2. Rehabilitation of Bridges (Plan B)
3. Base Condition Fix-as-Fails (Plan A)

The economic analysis suggests that fixing the current bridges as components deteriorate (Plan A – the Base Condition) will lead to excessive costs, particularly costs for travelers delayed in traffic.

The second alternative evaluated (Plan B) was major rehabilitation of the existing bridges. This scenario was supported by positive net benefits and a benefit-cost-ratio of 3.2 for the Sagamore Bridge and 2.2 for the Bourne Bridge. The advantage of the rehabilitation is a lower initial construction cost for the project when compared to replacing the bridges. The disadvantages are the high impact it will have on traffic patterns during the time of construction due to lane and full bridge closures. In addition, the bridges will not be brought up to current engineering standards and regulations. The major rehabilitation alternative is a higher risk option due to the faster rate of deterioration in the future. Deterioration of these structures can increase exponentially as these bridges age and may warrant the need for replacement in the future.

The alternative for replacement bridges (Plan D) was evaluated for 6-lane bridges including auxiliary on/off lanes. The bridge replacement alternative had higher net benefits and a higher BCR than the rehabilitation scenario (6.9 for the Sagamore Bridge and 2.7 for the Bourne Bridge). The disadvantage of the replacement bridges is the high initial cost of construction. The advantages of the replacement bridges are minimal disturbances to traffic during construction and replacing the aging infrastructure with bridges that meet modern engineering standards and regulations. The new bridges would not require the level of frequent, costly, and escalating maintenance and repairs, or entail the high level of disruption to traffic and the economy of the region.

It is important to note that this analysis was performed under the assumption that the road infrastructure surrounding the bridges are in their current conditions and are not upgraded by the state of Massachusetts. If the state choses to improve the road network surrounding the bridges as planned, particularly near the Bourne Rotary and the improvements to Route 6, then the 6-lane replacement bridges will provide additional efficiency benefits of improved travel time by allowing the left-hand travel lanes to be fully used by through traffic, since exiting and entering traffic will use the acceleration/deceleration lanes. Shifting the exiting and entering traffic out of the right-hand through traffic lanes will also have benefits to traffic safety as conflicts between fast-moving and slow moving vehicles will be minimized.

The state is planning to make major highway safety and efficiency improvements in the connecting roads to both bridges should they be replaced. The state has committed to accessing available bonding authority to make these improvements. The recommended plan at this phase of the project is for the replacement of both the Bourne and Sagamore highway bridges with decks having 6 lanes, including 4 through traffic lanes plus 2 auxiliary (acceleration/deceleration) lanes, plus separate non-vehicular pedestrian and bicycle lanes on each bridge. The state improvements will be designed to accommodate the new bridge dimensions. Final bridge capacity and design will be determined during Phase II.

13.7 Value Engineering

A Value Engineering study was not performed at this phase of the analysis. In the next phase as the process for determining bridge type, location, and alignment is developed and the needs for additional investigations and analyses are determined, a Value Engineering study would be initiated. Insufficient information exists at this phase to scope and undertake a meaningful value engineering study.

14.0 THE RECOMMENDED PLAN

14.1 Description of the Recommended Plan

The recommended plan moving into the next phase of design analysis is replacement of each of the two highway bridges crossing the Cape Cod Canal FNP at Bourne and Sagamore. Final design would conform to AASHTO and MassDOT design standards current at that time. Subject to additional analysis during Phase II the new bridges will have two through travel lanes and one auxiliary (acceleration/deceleration) lane in each direction, for a total of 6 lanes on each new bridge. The conceptual design evaluated at this stage of study consists of the following:

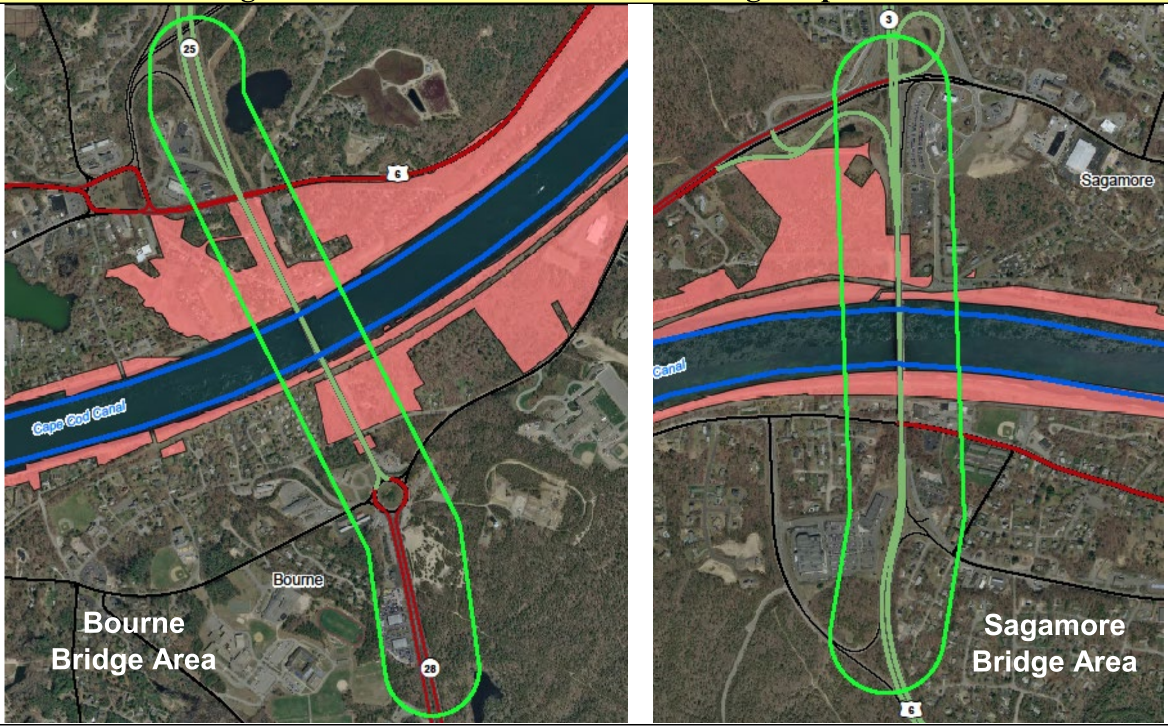
1) Construction of two new highway bridges each located parallel to and immediately inshore of the existing Bourne and Sagamore Bridges. A new Sagamore Bridge would be located southwest of the existing bridge. A new Bourne Bridge would be located northeast of the existing bridge.
2) Each new bridge would include 4 through travel lanes (2 in each direction) each 12 feet wide.

3) Each new bridge would have two auxiliary lanes for acceleration/deceleration (entrance and exit), one in each direction, each 12 feet wide.
4) Each new bridge would have a minimum vertical clearance for navigation of 135 feet above mean high water over the width of the navigation channel, increased 7.8 feet for anticipated sea level change (high rate).
5) Each new bridge would have deck and approach grades of no steeper than 4%.
6) Each new bridge would include one non-vehicular lane for pedestrian and bicycle traffic with separation between the non-vehicular lane and the vehicle traffic lanes.
7) Each new bridge would include a shoulder on the vehicle deck, 10 feet wide, in each direction.
8) Each new bridge would include a median with barriers to separate northbound and southbound vehicular traffic.
9) A conceptual cable-stay design was used for this analysis, but actual bridge type and other design parameters will be developed in the next phase.
10) The existing bridges would remain in service (operated, maintained and repaired as needed) until the new bridges are opened to traffic.
11) The existing bridges would be demolished upon opening of the new bridges. The steel components would be scrapped. The method of demolition and removal would be determined during the next phase.
12) Licenses and easements for placing new electric transmission and telecommunications cables on the new bridges would need to be proposed by the utility owners and negotiated. Placement of new gas lines would not be allowed on the new bridges.
13) Detailed design features such as lighting, fire suppression, suicide prevention barriers, signage and pavement markings, traffic barriers and controls, etc., would be determined during the design phase of the project.

This study was conducted to determine whether major rehabilitation or bridge replacement would be the most cost effective, safe and reliable solution to providing vehicular crossings over the Cape Cod Canal. A conservative approach was taken developing a conceptual design for new crossings. This included the bridge type selected, lane widths, approach grades, and sea level rise. The replacement bridge designs presented therefore include an increased bridge clearance to accommodate current vessel traffic at the high rate of sea level rise. Final elevations of the bridges and corresponding air draft clearance will take approach work and adjacent infrastructure into consideration during design phase (Phase II) of the project. This will include a further evaluation of the most appropriate scenario of sea level rise to include in the final design elevation.

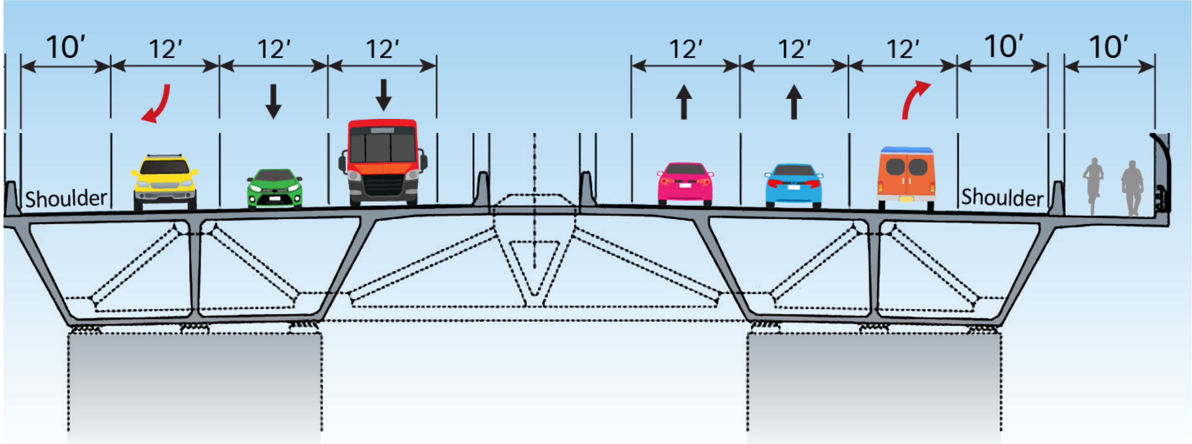
Locations and cross sections of the new bridges are shown in Figures 27 and 28.

Figure 27 – General Locations for Bridge Replacement



Replacement bridges would likely be located close to the existing bridges so as to minimize the approach road modification necessary to connect them, and to minimize impacts to area residents and businesses.

Figure 28 – Deck Sections for Conceptual Replacement Bridge Design



The concept for replacement bridges used in this analysis would have two through travel lanes and one auxiliary entrance/exit lane in each direction. Shoulders would also be provided in each direction. A non-vehicle lane for pedestrians and bicycles would be included as would a median to separate directions of traffic.

14.2 Outputs of the Recommended Plan Compared to Major Rehabilitation

The rehabilitation and replacement alternatives were each measured against the Base Condition. The costs and benefits of these plans are shown in the table below. For this analysis project costs included the cost of design and implementation for the new bridges, the cost of future OMR&R for the new bridges, the cost of associated state modifications and improvements necessary to connect the new bridges to the regional highway system and local roadways, and costs for lands, easement, rights of way and utility relocations. Travel delays for vehicle and navigational traffic were treated as costs for the purposes of economic analysis. A comparison of the costs and benefits of the rehabilitation and replacement plans is shown in Table 49. Cost estimates developed at this phase were developed at a conceptual level to compare rehabilitation vs. replacement and are not intended for budgeting purposes.

The results indicate that Bridge Replacement with construction of two new 6-lane bridges has a higher benefit to cost ratio than maintaining the bridges in a "fix-as-fails" Base Condition. In addition, the cost-benefit ratios are also higher than for Major Rehabilitation of the existing bridges. This study showed that replacement of each of the two highway bridges results in positive net annual benefits and benefit-cost-ratios greater than 1. Additional benefits would accrue due to improved traffic and highway safety, and reliability of the new bridges as part of the larger highway system over their expected life cycle of 75 years or more. These additional benefits would be investigated and quantified during Phase II.

The existing highway bridges would be demolished once the new bridges have been placed in service. Demolition activities would likely occur on land and from the water. Demolition would open up the former bridge footprint for other uses such as recreation. The steel in the existing bridges is a valuable commodity and part of the cost of demolition could be recovered by the government from its sale as scrap.

Table 49 – Comparison of Rehabilitation and Replacement Plans

FY 2020 Prices ($000s – March 2020)	Major Rehabilitation	Replacement Bridges
Sagamore Bridge		
Total Federal First Cost	$156,300	$428,300
Future Federal OMR&R	$144,400	$15,800
State-Funded Approaches	- - -	$57,800
Total First Cost	$300,700	$501,900
Travel Delay Costs	$1,281,300	$92,800
Total – Sagamore	$1,582,000	$594,700
Total Cost Discounted + IDC	$969,500	$469,000
Total Annual Cost – 2-3/4% (0.03704)	$35,900	$17,400
Total Annual Benefits	$115,100	$119,500
Annual Net Benefits	$79,200	$102,100
Benefit-Cost Ratio	3.2	6.9

Table 49 (Continued) – Comparison of Rehabilitation and Replacement		
FY2020 Costs	Rehabilitation	Replacement
Bourne Bridge		
Total Federal First Cost	$186,200	$630,800
Future Federal OMR&R	$158,900	$7,900
State-Funded Approaches	- - -	$91,000
Total First Cost	$345,100	$729,700
Travel Delay Costs	$948,400	$22,400
Total – Bourne	$1,293,500	$752,100
Total Cost Discounted + IDC	$731,100	$574,400
Total Annual Cost – 2-3/4%	$27,100	$21,300
Total Annual Benefits	$59,100	$58,300
Annual Net Benefits	$32,000	$37,000
Benefit-Cost Ratio	2.2	2.7

14.3 Impacts of the Recommended Plan

The cost and economic impacts of the recommend bridge replacements are described above. The new bridges would require realignment of state highway approaches and some local roadways. The new bridge footprints would likely require some amount of real estate acquisition, estimates for which are included in the project costs. Replacement would have a far lesser impact on vehicular traffic, but a greater impact on marine traffic, than the other alternatives.

There would be impacts to the environment from construction of new bridges. A minor amount of wetlands habitat would be lost. The Northern Long Eared Bat is known to roost in the area. A survey will be conducted during Phase II to determine if there would be any impact to this and other listed species from the project.

There is also a potential for impacts to cultural resources. Visually, depending on the final bridge design chosen, the view of the Canal would change for the first time in more than 80 years. There is a potential that some level of cultural resource mitigation would be required for replacement of the bridges, since the existing bridges are historic structures and would be removed as part of any replacement project. At a minimum this would involve document of the 1935 bridges, their design and construction, history and place in the cultural setting of Cape Cod and the communities around the Canal.

Detailed cultural resource surveys have not been done at this first phase of the project. There are some know cultural resources in the vicinity of the bridges and the potential areas for the new bridges. Surveys for potential and known cultural resources in the final bridge footprint would be conducted in Phase II.

With an easing in traffic congestion, quality of life should improve for the residents and visitors to the Cape and Islands. Modern bridges with adequate dimensions should reduce traffic delays and vehicle accidents and make daily life less stressful to motorists. Due to other limits on housing and commercial development on the Cape, the new bridges should not induce even further development of the region.

14.4 Non-Federal Requirements for the Recommended Plan

Initial construction as well as operation, maintenance, repair and rehabilitation of the Canal and its bridges since original acquisition by the Federal Government have not required any non-Federal cooperation. Modifications made to some of the small boat harbors appurtenant to the Canal have required Sponsor agreements. Replacement of the two highway bridges is within the existing authority for the Federal Navigation Project for the Cape Cod Canal and will not require any non-Federal participation or additional legislative authority. However non-Federal interests will need to perform a number of costly modifications to State and local roadways and other works for bridge replacement to succeed.

Constructing two new bridges, even immediately adjacent to the existing bridges, will require realignment and relocation of connecting state highways and local roadways. New state and local highway and roadway modifications, including realigned connecting roads, approach ramps, signaling, lighting, and signage will all be required. State acquisition of real estate may be required to effect this work. The costs of performing this work, including all design and permitting, will be a non-Federal cost. Estimates have been made of these costs for state highways and local roadways based on the concept level bridge design and included in the total project costs for the bridge replacement alternatives. The state has plans for major transportation improvements in the area of the Canal in the coming years, beyond what is required to accommodate Federal construction of bridge replacement. State plans for highway modifications, both in support of new bridge construction and other improvements, will be examined again during Phase II design efforts so as to minimize impacts to the natural and human environment, and assure implementation of a safe and efficient transportation system.

The concept level design includes relocation of the two highway bridges, changes to the bridge deck elevations, and easing of grades on the bridges and their approach spans. Federal acquisition of additional state and municipal lands, some private lands, and easements and rights of way will be required. These costs will be Federal costs, though some assistance from state and local governments will be required for acquisitions.

Costs for utility relocations are included in the total project cost. Some utilities will be relocated to the new bridges, while others (natural gas lines) will be moved off the bridges and will need other means of crossing the Canal and connecting to their land-side facilities. These costs will need to be borne by the utility owners.

Tolls are not permitted on Federal bridges or on Federal bridges that are transferred to state or local control under the provisions of the River and Harbor Act of 1950. If the state wishes to recover some of its costs for the project through tolls it must do so on its own roads, and not on the bridges, even if it ultimately assumes ownership of the bridges.

14.5 Project Operations and Maintenance Manual

A Project Operations and Maintenance (O&M) Manual will be prepared for each new bridge as it nears completion of initial construction. The O&M Manual will document the details of project design, describe the construction process and timeline, document the as-built condition (including providing as-built drawings), and set forth the requirements and anticipated schedule for long-terms programs for OMRR&R for each new bridge.

14.6 Project Management Plan

A Project Management Plan was developed for this first phase of the investigation of the Cape Cod Canal Highway Bridges. An updated Project Management Plan will be developed for the Phase II once approval to proceed with that effort has been received. That updated PMP will cover all aspects of the remaining investigations and analyses needed to determine the final bridge type, location, alignment, LERRDs, environmental and social impacts, final NEPA document, and schedule and budget for all remaining detailed design studies and implementation.

15.0 MAJOR REHABILITATION CLASSIFICATION

The proposed replacement of the Cape Cod Canal Bourne & Sagamore Bridges falls within the guidelines established in ER 1130-2-500, 27 December 1996, last updated 1 June 2006, Chapter 3 - Major Rehabilitation. The replacement of the two highway bridges would provide a safe and reliable means for both commercial and non-commercial vehicular traffic to cross the Cape Cod Canal, a Corps operated Federal Navigation Project. The work is intended to improve the reliability physical life which will result in a deferral of capital expenditures to rehabilitate the bridges and will preclude significant future emergency repairs. The replacement will cost more than the threshold amount of $5,300,000 for reliability improvements and will not consist of routine or deferred maintenance. Replacement is more cost effective than major rehabilitation of the bridges for the purpose of restoring reliability.

16.0 PROJECT COST SUMMARY

The estimated cost of the Recommended Plan at this conceptual level of analysis is shown in the table below. Project design and construction costs for Federal and State improvements are presented in base program year price levels of Fiscal Year 2020 in Table 50. These program year costs were used for comparison of detailed plans and selection of the recommended plan as shown in Table 49 above. The cost of major repairs for the 50-year analysis period are also shown. These estimates were developed based on concept level plans and are not adequate for use in budgeting for implementation. Cost certification at this phase is conditional due to the limited scope of the analysis. The next phase of the project will include more detailed investigations, final bridge locations and designs, and more detailed and refined cost estimates.

Table 50
Implementation Costs for the Recommended Plan – Plan D (Updated March 2020)

Initial Program Year Cost (FY20) of Project Design and Construction	**Bourne Bridge**	**Sagamore Bridge**	**Total for Both Bridges**
Federal Bridge Replacement			
Construction Cost	$355,478,000	$232,630,000	$588,108,000
Contingency Cost (44%)	$156,410,000	$102,357,000	$258,767,000
Planning, Engineering & Design	$40,951,000	$27,321,000	$68,272,000
Construction Management	$14,199,000	$9,594,000	$23,793,000
Total Construction	$567,038,000	$371,902,000	$938,940,000
Cultural Resource Preservation	$29,450,000	$19,241,000	$48,691,000
Lands, Easements, Rights of Way	$7,645,000	$7,618,000	$15,263,000
Utility Relocations (Non-Fed Cost)	$26,640,000	$29,520,000	$56,160,000
Total Federal Project Cost	$630,773,000	$428,281,000	$1,059,054,000
Associated Non-Federal Highway/Roadway Modifications			
State Funded Bridge Approaches	$90,991,000	$57,802,000	$148,793,000
Total Federal + State Initial	$721,764,000	$486,083,000	$1,207,847,000
Anticipated Future Major Repair Actions for New Bridges			
Years for Major Repairs	2054	2049 & 2069	
Major Repairs #1 (2054/2049)	$7,911,000	$7,906,000	$15,817,000
Major Repairs #2 (None/2069)		$7,906,000	$7,906,000
Total Cost of Future Repairs	$7,911,000	$15,812,000	$23,723,000
Total Project Cost – Federal 50 Years + State			
Total Project Cost (50 Years)	$729,675,000	$501,895,000	$1,231,570,000

Fully funded costs are provided in Appendix C - Cost Engineering, and escalate the costs to the mid-point of construction for each action. A cost summary for implementation of the recommended plan at the fully funded level is shown below in Table 51.

Table 51
Fully-Funded Implementation Costs for the Recommended Plan – Plan D

Project Design and Construction FY20 – Updated March 2020	**Bourne Bridge**	**Sagamore Bridge**	**Total for Both Bridges**
Federal Bridge Replacement			
Construction Cost	$514,867,000	$290,645,000	$805,512,000
Contingency Cost (44%)	$226,541,000	$127,884,000	$354,425,000
Total Contracts	$741,408,000	$418,529,000	$1,159,937,000
Planning, Engineering & Design	$46,277,000	$30,875,000	$77,152,000
Construction Management	$22,868,000	$12,721,000	$35,589,000
Total Construction	$810,553,000	$462,125,000	$1,272,678,000
Cultural Resource Preservation	$42,655,000	$24,039,000	$66,694,000
Lands, Easements, Rights of Way	$8,423,000	$8,393,000	$16,816,000
Utility Relocations (Non-Fed Cost)	$36,370,000	$34,765,000	$71,135,000
Total Federal Project Cost	$898,002,000	$529,322,000	$1,427,324,000
Associated Non-Federal Highway/Roadway Modifications			
State Funded Bridge Approaches	$130,335,000	$72,046,000	$202,381,000
Total Federal + State Initial	$1,028,337,000	$601,368,000	$1,629,705,000
Anticipated Future Major Repair Actions for New Bridges			
Years for Major Repairs	2054	2049 & 2069	
Major Repairs #1 (2054/2049)	$24,000,000	$20,343,000	$44,343,000
Major Repairs #2 (None/2069)		$39,464,000	$39,464,000
Total Cost of Future Repairs	$24,000,000	$59,807,000	$83,807,000
Total Project Cost – Federal 50 Years + State			
Total Project Cost (50 Years)	$1,052,337,000	$661,174,000	$1,713,511,000

17.0 SUMMARY AND CONCLUSIONS

This study was initiated for the purpose of determining whether a program of major rehabilitation and repair or a project for replacement of one or both highway bridges over the Cape Cod Canal was the most cost-effective long-term means of meeting the USACE obligation to provide vehicular crossings over the Canal. This study has determined that providing two new highway bridges would be the most cost effective means of providing safe and reliable crossings. The existing bridges are 85 years old and are functionally obsolete.

A new high level fixed span bridge would be constructed immediately adjacent to each of the two existing highway bridges so as to minimize the modifications needed to the connecting roadways on both the mainland and the Cape. The new highway bridges would be designed to include access for both pedestrians and other non-vehicular traffic such as bicycles. To improve traffic safety and through traffic reliability each bridge would include one acceleration/deceleration lane and two through traffic lanes in each direction, for a total of six vehicular lanes on each bridge.

The two existing bridges would remain in in operation until the new bridges are opened to traffic. The fate of the two existing bridges will be determined in the detailed design phase, but for now it is assumed that they would be closed to traffic and demolished once the new bridges are opened. The USACE would need to determine the scrap value of the existing bridges during the detailed design phase.

The two existing bridges are now coming up on their second major rehabilitation. The first rehabilitation of the Sagamore Bridge was carried out in 1981 to 1983. The first rehabilitation of the Sagamore Bridge was carried out in 1979 to 1981. The second rehabilitation of the Sagamore Bridge would be scheduled for 2025-2027 and cost about $185 million fully funded. The rehabilitation work on the Bourne Bridge would be carried out in 2029-2031 at a cost of about $210 million. During these periods the work would require a total of about 760 days of lane closures and 310 days of full bridge closures, with consequences to traffic and the local economy.

A program of critical repairs may be able to delay the full rehabilitation starts by a few years, but if bridge replacement is approved any more delay in implementing that work would require rehabilitation to proceed. In other words, any appreciable delay in decision-making or funding could force the Government to pursue major rehabilitation instead of bridge replacement in order to maintain reliability and safety of vehicular traffic over the Canal in the near term.

The Commonwealth of Massachusetts would be a necessary partner in any rehabilitation or replacement project. However, the State's principal role would involve redesign and relocation of connecting highways and roadways if bridge replacement is pursued. The State has proposed more than $350 million in future infrastructure funds in the 2019 Transportation Bond Bill for work in the coming years. About $120 million of this would be required for the state-funded bridge approaches as part of the bridge replacement, including pre-design regulatory coordination. This also would include additional road improvements in the area around and the highways leading to the Canal. Any delays in Federal funding could put much of that State commitment for the Canal area work in question.

There is a level of urgency in Federal and State decision making concerning the recommended bridge replacement project and the funding to implement it. This report provides a detailed discussion of the issues involved to aid in that decision making process. Approval of this report and its recommendation would allow the USACE to proceed with Phase II of the process – the identification of the final replacement bridge location, alignment, size and type, complete Federal, State and local regulatory coordination, including conclusion of the NEPA process, and initiate final design.

18.0 RECOMMENDATION

The USACE has determined that there is sufficient justification for pursuing a program of bridge replacement for both the Bourne and Sagamore highway bridges over the Cape Cod Canal, Massachusetts Federal Navigation Project. An evaluation of costs and benefits indicates that the most cost effective long-term means of providing vehicular crossing of the Canal is replacement of both bridges with new bridges that conform to modern highway design standards. This recommendation considers both safety and reliability of the bridges and the waterway they cross for both surface vehicular and marine transportation. The next phase of the investigation will determine final bridge type and other detailed design parameters, with such further modifications thereto as in the discretion of the Chief of Engineers may be advisable.

The recommendations contained in this report reflect the information available at this time and current USACE Departmental policies governing formulation of individual projects. They do not reflect program and budgeting priorities inherent in the formulation of a national Civil Works construction program nor the perspective of higher review levels within the Executive Branch. Consequently, the recommendations may be modified before they are approved for implementation funding.

11 MAR 2020
Date

William M. Conde
Colonel, Corps of Engineers
District Engineer

ENVIRONMENTAL ASSESSMENT AND FINDING OF NO SIGNIFICANT IMPACT FOR MAJOR REHABILITATION EVALUATION

CAPE COD CANAL HIGHWAY BRIDGES
MASSACHUSETTS

Prepared by:
New England District
U.S. Army Corps of Engineers
696 Virginia Road
Concord, Massachusetts 01742

MARCH 2020

This Page Intentionally Left Blank

Table of Contents

1.0 INTRODUCTION 1
  1.1 Background 1
2.0 AUTHORIZATION AND REGULATORY HISTORY 1
  2.1 Congressional Authorizations 1
  2.2 National Environmental Policy Act (NEPA) Compliance 2
3.0 PROJECT SCOPE AND STUDY AREA 2
  3.1 Scope 2
  3.2 Location and Description 3
  3.3 Study Area 3
4.0 PURPOSE AND NEED 4
  4.1 Purpose 4
  4.2 Need 4
5.0 ALTERNATIVES ANALYSIS 5
  5.1 Alternatives Considered but Not Carried Forward 5
    5.1.1 Replacement of Both Bridges with a Single Bridge 5
    5.1.2 Construction of a New Third Highway Bridge 6
    5.1.3 Replacement of One or Both Highway Bridges with Tunnels or a Single Tunnel 6
    5.1.4 Replacement of One or Both Bridges with Low Level Draw Spans or Low Level Causeways 7
    5.1.5 Deauthorization and Closure of the Canal 7
    5.1.6 Alternative C - Replacement of Both Highway Bridges with New Bridges – 4 Lanes 8
  5.2 Alternatives Evaluated 9
    5.2.1 Alternative A - No Action (Without Project Condition) 9
    5.2.2 Alternative B - Major Rehabilitation for Both Bridges 10
    5.2.3 Alternative D (Preferred Alternative) - Replacement of Both Highway Bridges with New Bridges – 4 Lanes and 2 Auxiliary Lanes 10
6.0 AFFECTED ENVIRONMENT and ENVIRONMENTAL CONSEQUENCES 11
  6.1 Physical Resources 11
    6.1.1 Land Use 11
    6.1.2 Terrain and Topography 13
    6.1.3 Geology/Soils 14
    6.1.4 Climate 15
    6.1.5 Seal Level Change 15
    6.1.6 Air Quality 16

6.2 Water Resources 19
- 6.2.1 Surface Water and Wetlands 19
- 6.2.2 Water Quality 22
- 6.2.3 Groundwater 24
- 6.2.4 Floodplains 25

6.3 Coastal Resources 26
- 6.3.1 Coastal Zones 26
- 6.3.2 Coastal Barrier Resources System 28

6.4 Biological Resources 29
- 6.4.1 Vegetation 29
- 6.4.2 Wildlife 31
- 6.4.3 Fisheries and Marine Wildlife 33
- 6.4.4 Threatened and Endangered Species 36

6.5 Historic and Archaeological Resources 43

6.6 Socioeconomics Resources 46
- 6.6.1 Demographics 46
- 6.6.2 Community Economics 50
- 6.6.3 Land Use and Zoning 55
- 6.6.4 Recreation 57
- 6.6.5 Public Utilities 59
- 6.6.6 Public Health and Safety 62
- 6.6.7 Traffic 70
- 6.6.8 Environmental Justice 78
- 6.6.9 Hazardous Materials and Waste 84
- 6.6.10 Noise 87

6.7 Summary of Effects 90

7.0 INDIRECT EFFECTS AND CUMULATIVE IMPACTS 96

7.1 Induced Development 96
- 7.1.1 Development Potential 96
- 7.1.2 Traffic Modelling 99
- 7.1.1 Population models and forecasted growth 101

7.2 Cumulative Impacts 103
- 7.2.1 Bourne Rotary Alternatives 104
- 7.2.2 Bourne Rotary with Highway Interchange 106
- 7.2.3 Belmont Circle 107
- 7.2.4 Route 6 Exit 1C Relocation 109
- 7.2.5 Route 6 Additional Eastbound Travel Lane 110

7.2.6 Total Cumulative Impacts 112

7.3 Cumulative Significance 112

7.4 Other Development Projects 112

8.0 PUBLIC INVOLVEMENT 113

8.1 Initial Study Comments Pre-Draft 114

8.2 Draft EA Public Comments 116

9.0 AGENCY COORDINATION 119

10.0 COMPLIANCE WITH ENVIRONMENTAL FEDERAL STATUTES AND EXECUTIVE ORDERS 120

List of Figures

EA Figure 1 – Cape Cod Canal 3
EA Figure 2 – Project Study Area 4
EA Figure 3 – Land Use 12
EA Figure 4 – Wetlands 20
EA Figure 5 – MassDEP Wetlands 21
EA Figure 6 – Cape Cod Sole Source Aquifer 24
EA Figure 7 – Floodplain 26
EA Figure 8 – Coastal Zone and Coastal Barrier Resources 27
EA Figure 9 – EFH in the Cape Cod Canal 35
EA Figure 10 – Federally-listed species and critical habitat in the Cape Cod Canal 39
EA Figure 11 – MA NHESP Priority habitats of rare species and ACECs 42
EA Figure 12 – Second Home Population. 48
EA Figure 13 – Bourne Zoning Map 56
EA Figure 14 – Fire and Police Stations in the Town of Bourne 65
EA Figure 15 – Number of monthly crashes within one mile of the bridges (2010 – 2014) 68
EA Figure 16 – Traffic Routes 71
EA Figure 17 – Average Daily Volume of Traffic 72
EA Figure 18 – Minority Population in Cape Cod and Islands, National Percentiles 79
EA Figure 19 – Minority Population in the Study Area, National Percentiles 80
EA Figure 20 – Low-Income Population in Cape Cod and Islands, National Percentiles 82
EA Figure 21 – Low-Income in the Study Area, National Percentiles 83
EA Figure 22 – Hazardous sites and groundwater study plumes in the study area 85
EA Figure 23 – Cape Cod Residential and Nonresidential Development 97
EA Figure 24 – Traffic Congestion Areas on the Cape 101
EA Figure 25 – MassDOT Conceptual Improvement Projects 104
EA Figure 26 – MassDOT Alternatives Evaluated – Bourne Rotary 105
EA Figure 27 – MassDOT Bourne Rotary Interchange 107
EA Figure 28 – MassDOT Alternatives Evaluated – Belmont Circle 108
EA Figure 29 – MassDOT Route 6 Exit 1C Relocation 110
EA Figure 30 – MassDOT Route 6 – Additional Eastbound Travel Lane and Westbound Auxiliary Lane 111
EA Figure 31 – Proposed Development Projects 113

List of Tables

EA Table 1 – Canal Tidal Datums in feet relative to Mean Sea Level 16
EA Table 2 – List of species that have designated EFH in the Cape Cod Canal 34
EA Table 3 – Total Population 47
EA Table 4 – Proportion of seasonal-use houses 47
EA Table 5 – Age and Ethnicity 49
EA Table 6 – Education, Employment and Income 49
EA Table 7 – Proportion of Individuals Employed by Industry 51
EA Table 8 – Proportion of small businesses 52
EA Table 9 – Proportion of business in each industry 52
EA Table 10 – Total sales, shipments, receipts, revenue and business done by establishments 53
EA Table 11 – Median housing values and rent 53
EA Table 12 – Cost of living indices for Bourne, Plymouth and Wareham 54
EA Table 13 – Cape Cod resident recreational participation 58
EA Table 14 – Utility Licenses 60
EA Table 15 – Estimated Population Exposure to Hurricane Hazard 63
EA Table 16 – Estimated Cape Clearance Times 64
EA Table 17 – Change in travel time from the Bourne Police Department to the south side of the bridges 66
EA Table 18 – Average Travel Time of Major Routes 74
EA Table 19 – Average Travel Time by Closure 2014 75
EA Table 20 – Average Travel Time by Closure 2040 75
EA Table 21 – Emergency repair and associated travel restrictions 76
EA Table 22 – Rehabilitation Lane Closure Duration Estimates 77
EA Table 23 – Percent Minority 81
EA Table 24 – Median Household Income 84
EA Table 25 – Project Alternatives: Summary of Potential Effect, Coordination and Mitigation 90
EA Table 26 – Cape Cod Buildouts by Town 98
EA Table 27 – Average speed over 13 segments of road with existing and new bridges during weekdays (WD) and weekends (WE) in fall, summer and winter seasons 100
EA Table 28 – Cape Cod Summer Traffic Growth by Subregion 102
EA Table 29 – Bourne Rotary - Environmental Impact by Alternative 106
EA Table 30 – Bourne Rotary with Highway Interchange - Environmental Impact 107
EA Table 31 – Belmont Circle Reconstruction - Environmental Impact by Alternative 109
EA Table 32 – Route 6 Exit 1C Relocation - Environmental Impact 110
EA Table 33 – Route 6 Additional Eastbound Travel Lane - Environmental Impact 111
EA Table 34 – Total Cumulative Impacts for MassDOT Projects with Alternative 1 Scenarios 112
EA Table 35 – Pre-Draft Public Comments Summary 115
EA Table 36 – Post Draft Public Comments Summary 117

1.0 INTRODUCTION

1.1 Background

The Bourne and Sagamore bridges are two high level, fixed span highway bridges owned, operated, and maintained by the U.S. Army Corps of Engineers (USACE). The bridges provide access across the Cape Cod Canal and are part of the authorized Cape Cod Canal Federal Navigation Project (FNP). These two steel truss bridges were constructed in the 1930s and are now more than 83 years old.

The USACE, New England District, is conducting a multi-year Major Rehabilitation Evaluation Study (Study) of the Bourne and Sagamore highway bridges to evaluate whether continued repair and maintenance, major rehabilitation, or replacement of the bridges with new structures will provide safe, efficient transit for vehicular traffic across the Cape Cod Canal. The Study includes engineering, economic and environmental analyses, and evaluates alternatives to address deficiencies of bridge components that impact their structural and operational reliability. The study will result in a Major Rehabilitation Evaluation Report (MRER), a decision document that will provide the basis of decision-making for the USACE and Congress on the most cost-effective, safe alternative for providing critical public transportation access across Cape Cod Canal.

As part of the MRER, the USACE has developed an Environmental Assessment (EA) under the National Environmental Policy Act (NEPA) to examine the potential effects associated with the alternatives examined within the MRER.

2.0 AUTHORIZATION AND REGULATORY HISTORY

2.1 Congressional Authorizations

The Cape Cod Canal, which connects Cape Cod Bay and Buzzards Bay, was privately owned and built during the early 1900s. In 1919, Congress authorized the purchase of the Cape Cod Canal and in 1927 directed the USACE to operate and improve the canal under the authority of the Rivers and Harbors Act of 1927. The Rivers and Harbors Act of 1935 gave the authority for the USACE to operate and maintain the two highway bridges, Bourne and Sagamore, as part of the Cape Cod Canal Federal Navigation Project (P.L. 74-409). The Federal navigation project consists of:

- A 32-foot deep channel linking Buzzards Bay to Cape Cod Bay
- Dikes, revetments, jetties and other features to maintain functionality (that help keep the channel open)
- Mooring areas and small boat harbors in Sandwich and Bourne
- Buzzards Bay Railroad Bridge
- Access and recreation areas surrounding the canal
- Canal visitor center, Headquarters, traffic control and other operation and maintenance facilities

- Two high span highway bridges, the Bourne and Sagamore.

2.2 National Environmental Policy Act (NEPA) Compliance

NEPA requires Federal Agencies to assess the environmental effects of their proposed actions prior to making decisions. The USACE is preparing this Environmental Assessment (EA) pursuant to the White House Council on Environmental Quality (CEQ) Implementing Procedures for NEPA (40 CFR Parts 1500-1508) and USACE Procedures for Implementing NEPA (Engineering Regulation ER-200-2-2).

CEQ regulations direct Federal agencies to commence its NEPA process at the earliest possible stage and states that an EA may be supplemented at a later stage so an agency can focus on the issues which are ripe for decision and exclude from consideration issues not yet ripe (1508.28). Phase I of the bridge replacement project is the Cape Cod Canal Bridges Major Rehabilitation Evaluation Report (MRER) decision document. This EA has been prepared to support the Phase I, MRER decision document. A supplemental EA will be prepared during Phase II of the project (design and construction phase).

This EA describes existing conditions within the project area and analyzes potential direct, indirect and cumulative environmental effects associated with the project including alternatives to either repair or replace the Bourne and Sagamore Bridges and fulfills NEPA documentation requirements.

3.0 PROJECT SCOPE AND STUDY AREA

3.1 Scope

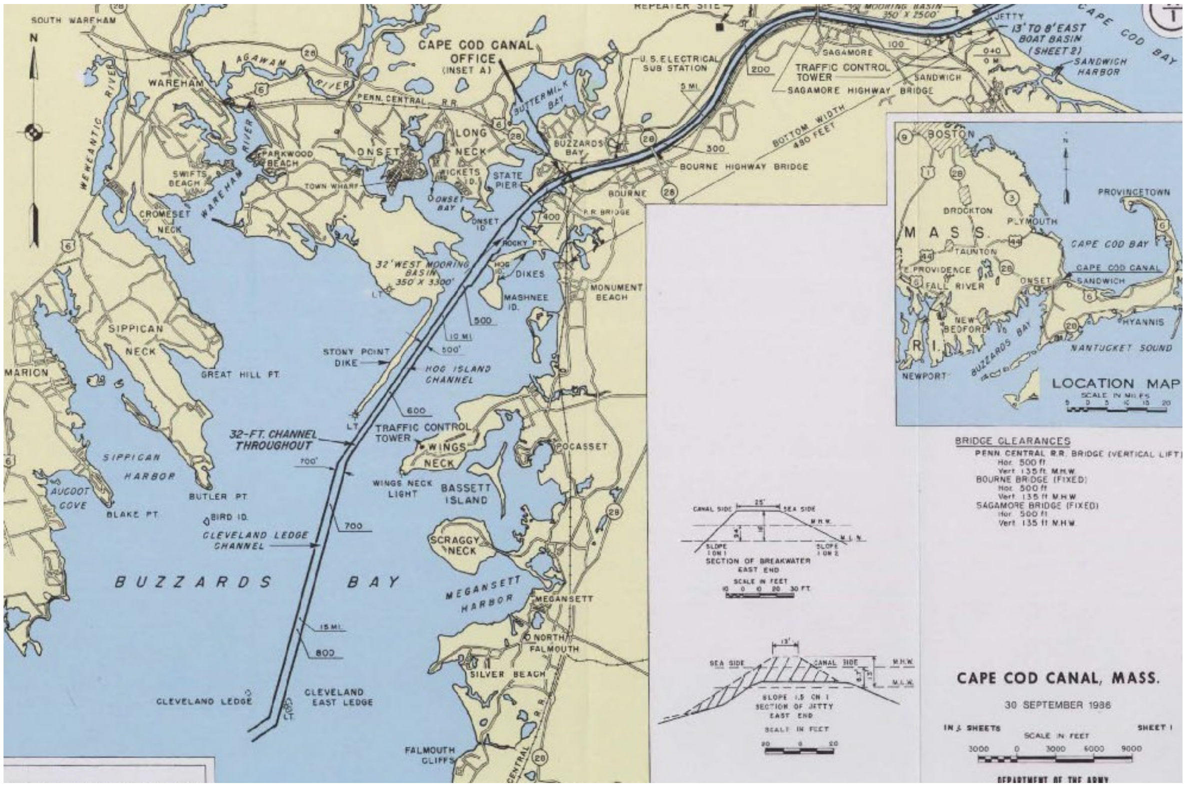
This EA accompanies the MRER as the first phase in determining the future of the Cape Cod Canal Highway bridges. This phase examines potential alternatives including major rehabilitation or replacement and recommends the most feasible measures for meeting future needs. The alternatives developed and evaluated in the MRER and accompanying EA are at a conceptual level until a more definitive design is determined in the next phase of the analysis. Some alternatives will be screened out from future consideration. Assumptions have been made for the purposes of conducting the evaluations presented at this phase. No decisions will be made at this phase on issues such as: future limits on traffic over the existing bridges, the specific alignment of any new crossing, any specific type of new bridge, the fate of the existing bridges should new crossings be built, the extent of any real estate acquisition, and other design details such as types and extent of pedestrian and bicycle crossings, roadway grades, utility relocations, construction methods, and navigation clearances.

The MA Department of Transportation (MassDOT) has completed a Cape Cod Canal Transportation Study, which includes several proposed conceptual road infrastructure improvement projects based on the assumption that the USACE will replace both the Bourne and Sagamore Bridges. These MassDOT conceptual project areas will be discussed in greater detail in the *Cumulative Impacts* section of this EA.

3.2 Location and Description

The Cape Cod Canal is located within the towns of Bourne, Sandwich, and Wareham in southeastern MA (Barnstable and Plymouth Counties) and is approximately 47 miles south of Boston and 190 miles northeast of New York City (EA Figure 1). The canal connects Buzzards Bay to the southwest with Cape Cod Bay in the northeast, and provides a shorter, inshore, more protected route between eastern New England ports and those of southern New England, New York, and points further south along the Atlantic coast. The Canal is part of the Atlantic Intracoastal Waterway that runs from Boston, MA to Key West, Florida and provides access to both commercial and recreational vessels.

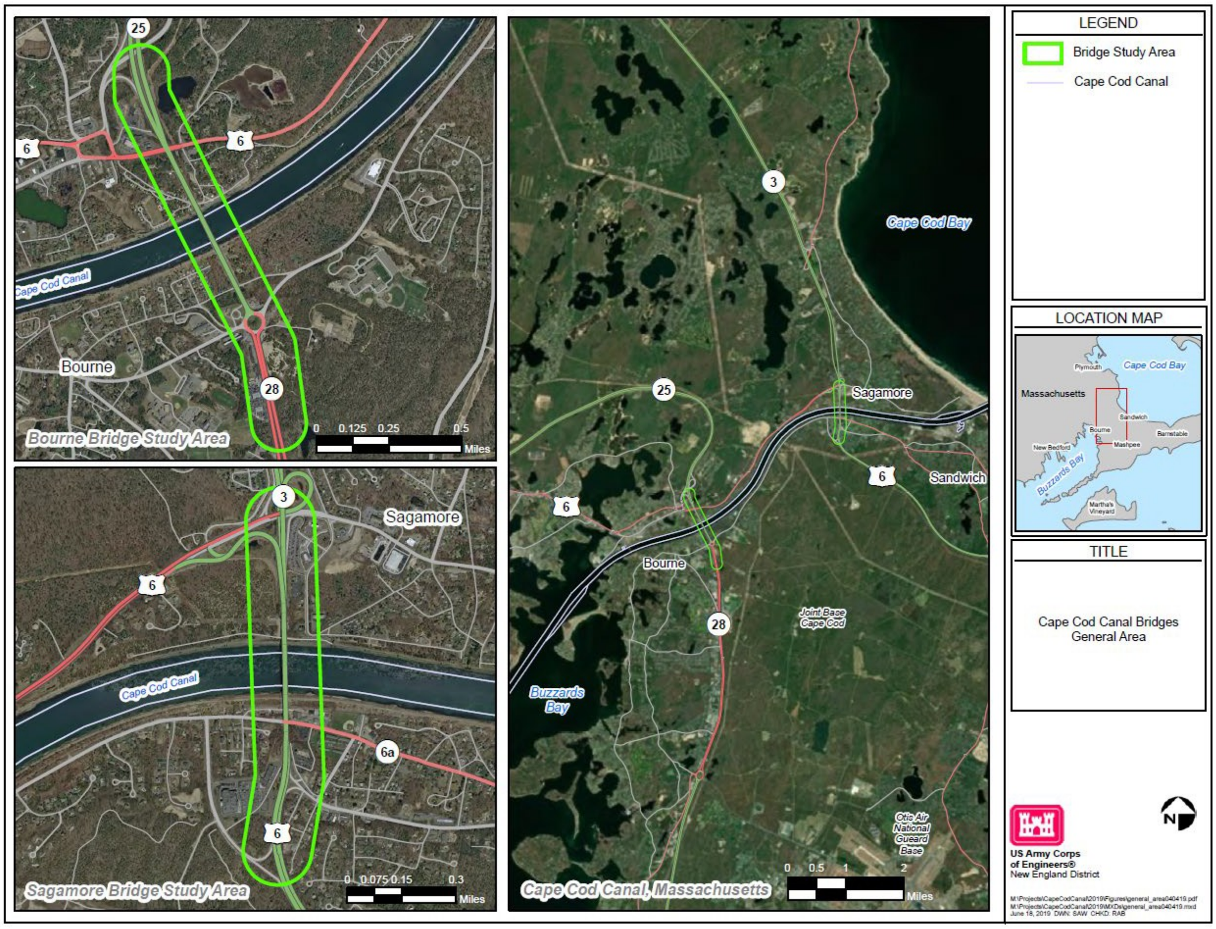
EA Figure 1- Cape Cod Canal



3.3 Study Area

For the purposes of this analysis, the study area is defined within an area consisting of 500 foot buffer zones around each potential bridge location including approaches for a total of 177 acres surrounding the Bourne Bridge and 128 acres surrounding the Sagamore Bridge, for a total of 305 acres. This total area includes land area on both sides of the Canal as well as the Canal itself. The Bourne study area extends from the highway overpass for the on/off ramp of Rt. 25 North to the north of the Canal and past the Bourne Rotary to Rt. 28 on the south side. The Sagamore study area extends from the intersection of Routes 3 and 6 to the north, and the Rt. 6 confluence with the Mid Cape Connector to the south (EA Figure 2).

EA Figure 2 – Project Study Area



4.0 PURPOSE AND NEED

4.1 Purpose

The purpose of the Cape Cod Canal Bourne and Sagamore Bridges project is to restore or replace the existing deteriorated bridges to provide structures which will maintain reliability of service, improve safety and ease of maintenance, and provide safe, secure, and cost effective access across the Cape Cod Canal.

4.2 Need

The existing Bourne and Sagamore bridges were constructed in 1933. Both bridges are now over 80 years old and despite ongoing maintenance, they have deteriorated over time and require increasingly more frequent repairs. Routine bridge maintenance will not extend the useful life or improve the reliability of the bridges.

The Bourne and Sagamore bridges provide the only vehicular access to 15 towns and nearly 215,000 full time residents and millions of annual visitors to Cape Cod. The bridges also provide access to eight offshore island municipalities through the ferry terminals located on Cape Cod. Routine and emergency maintenance activities require lane closures causing significant restrictions of each bridge's carrying capacity during these maintenance/repair events. While some maintenance can be performed outside of normal commuting hours, other emergency repairs cannot. Without major rehabilitation or replacement, travelers will experience more frequent delays and lane closures and the bridges may reach a point where load restrictions need to be imposed; adversely impacting traffic over both bridges.

The existing bridges were designed and built in the 1930s and do not meet current highway safety standards or adequately reflect modern-day traffic conditions. Traffic volumes have increased since the bridges were originally constructed, leading to significant increased loading and demands on the bridges' infrastructure. Routine maintenance will not be able to keep pace with current and projected traffic and loading demands.

5.0 ALTERNATIVES ANALYSIS

CEQ regulations require federal agencies to consider a reasonable range of alternatives that meet the purpose and need of a proposed action in their NEPA review. Reasonable alternatives include those that are practical or feasible from a technical and economic standpoint. A No Action alternative sets a baseline for existing human and natural environmental conditions to allow comparison between future without and with-project conditions, and to determine potential environmental effects of proposed with-project alternatives.

Numerous alternatives have been proposed for the future of the Cape Cod Canal highway bridges. Public comments were submitted during a series of five information meetings held in surrounding towns and municipalities in early December 2018 including Bourne, Plymouth, Nantucket, Martha's Vineyard, and Hyannis, Massachusetts. In addition, the public was able to submit written comments via the USACE Cape Cod Canal Bridges Project website established specifically for this project (Appendix F). The following sections describe various alternatives considered.

5.1 Alternatives Considered but Not Carried Forward in Detailed Analysis

5.1.1 Replacement of Both Bridges with a Single Bridge

A single bridge canal crossing has been proposed as early as 1931, when the USACE prepared a report that included a recommendation for a single highway bridge in the Bournedale vicinity to replace two existing draw span bridges. Before the single bridge project could be implemented, the Public Works Administration funded the design and construction of two bridges beginning in 1933.

Any new single crossing bridge would require substantial and significant infrastructure construction and involve extensive redesign and major realignment of local surface roads and regional highway connections on both the Cape and mainland sides of the Canal. Required changes in bridge approach grades and elevation for navigation clearance would compound these challenges. A new single crossing bridge would likely involve real estate takings, including lands from the Massachusetts Military Reservation as well as environmental and historical areas of concern identified in other "Alternatives Considered and Not Carried Forward" sections.

5.1.2 Construction of a New Third Highway Bridge

Construction of a third highway bridge, in addition to the two existing bridges, would require the same infrastructure construction considerations as the single bridge alternative as well as new MassDOT highways on either side of the canal. MassDOT initially studied the concept of a mid-canal crossing, but determined there were significant resource impact issues and this alternative was not carried forward in the MassDOT *Cape Cod Canal Transportation Study* (2019). Additionally, a third bridge alternative does not provide a solution for the existing Bourne and Sagamore Bridges that are in need of major rehabilitation or replacement.

5.1.3 Replacement of One or Both Highway Bridges with Tunnels or a Single Tunnel

For several decades, replacing or augmenting the existing bridges with a tunnel or several tunnels has been proposed. Tunnels are typically not cost effective when compared to bridge spans that are under a mile in length. Both the Sagamore and Bourne bridges are less than this distance. Associated costs are driven by tunnel design parameters including depth, grade, surrounding topography, existing natural foundation conditions, number of traffic lanes and top elevation of the tunnel with respect to the dredged navigation channel above it.

A key aspect of designing a Cape Cod Canal tunnel would involve consideration of the Canal's future as a deep draft waterway. If the navigation channel was widened or deepened in the future, a tunnel could pose a constraint to improving the Canal as a commercial waterway.

A tunnel alternative would also require extensive reconfiguration of existing approach highways to meet the required tunnel entrance and exit slopes as well as existing land elevations on either side of the canal.

Tunnels have a higher capital cost and require additional levels of maintenance. The crossing of major transportation corridors, waterways, and other buried infrastructure also adds significant costs to a tunnel project.

Maintenance of a tunnel is more complicated than maintaining a bridge and must include structural as well as mechanical systems such as ventilation fans, dewatering pumps (both during and post-construction), and fire suppression systems.

Based on historic soil boring logs for the existing bridges and depth to bedrock in this area, a tunnel would likely be located within sandy soils creating significant dewatering and stability issues during construction, and would require continued dewatering and waterproofing issues post-construction. There would be excessive costs associated with reaching bedrock.

Tunnels require venting plants that are built to accommodate airflow from the venting shafts inside the tunnel. These venting structures are expensive to build, require above ground land for construction, and could be aesthetically unpleasing in the Cape Cod environment.

Other considerations include the fact that tunnels have significant height restrictions which limit oversized vehicles and bicycle and pedestrian travel is generally not permitted within tunnels of any length due to air quality and safety concerns.

Based upon all of these factors, the use of a tunnel is not a cost effective or practicable alternative to rehabilitation or replacement of the existing bridges.

5.1.4 Replacement of One or Both Bridges with Low Level Draw Spans or Low Level Causeways

During the December 2018 public information meetings for this study, some members of the public suggested that present-day use of the Canal for navigation might allow for a return to low-level bridge crossings that pre-dated the 1930's high-level bridge designs. These crossings would only allow small craft traffic to pass beneath the bridges at limited tidal stages.

Public comment in the initial information meetings also included suggestions that new crossings could be constructed by replacing the existing bridges with causeways. These would either be culverts that would permit tidal exchange, effectively converting the Canal to an estuary, or they would be low level bridge openings that would permit limited navigation access for small craft at certain tidal stages.

As the Canal is still actively transited by large commercial vessels including cruise ships, training vessels, cargo carriers, and barges, low level crossings would not be feasible due to the height of these vessels.

5.1.5 Deauthorization and Closure of the Canal

Members of the pubic have suggested that the Canal has outlived its purpose due to limited deep-draft navigation utility and should be deauthorized and abandoned. These commenters believe that filling in the Canal and restoring surface highways would save significant public funds.

The canal is 480 feet wide, 32 feet deep and 17.4 miles long. It saves commercial and recreational vessels 65 to as much as 150 miles of travel between Cape Cod Bay and Buzzards Bay along a route known as the Atlantic Intracoastal Waterway which is better protected and less risky than the open Atlantic side of Cape Cod. Approximately 14,000 vessels use the canal each year.

The canal has been in service since 1914 and was widened in 1940 creating suitable habitat for bass, flounder, cod, and mackerel, which provides recreational fishing opportunities along the Canal. Other wildlife species including migratory birds utilize the canal, and on occasion, the North Atlantic Right Whale, one of the world's most critically endangered species, transits through the canal.

Filling in even a portion of the canal would eliminate navigational benefits and significantly impact the existing aquatic environment which includes a two-way reversing tidal current that creates a unique coastal environment. Filling in the canal would require 3 million cubic yards of material per mile as well as additional material for crossings to meet grade levels at existing banks. This could potentially impact the availability of suitable fill for a large area of southeastern Massachusetts. A partial filling of the canal (only at the crossings), while lower in cost, would still result in navigation and environmental impacts. Multiple small bridges or culverts would be needed to maintain water exchange between canal crossings. The USACE has considered the potential impacts of filling in the canal and has determined this is not a practicable alternative due to the significance of these impacts.

5.1.6 Alternative C - Replacement of Both Highway Bridges with New Bridges – 4 Lanes

Under this alternative, new bridges would be constructed adjacent to the existing bridges, and the old bridges would be removed upon project completion. This alternative involves moving the bridge abutments further north and south on each side of the Canal in order to produce approach grades consistent with modern federal highway standards. The piers would be moved from in-water to the Canal shoreline.

In order to minimize impacts to connecting roads, other non-Federal highways, and local roadways, each new bridge would be placed along approximately the same alignment as the existing bridges, parallel to them, and offset by the width of the new bridges. This would minimize the real estate takings needed for the new bridges and connecting road modifications.

A new bridge would need to account for changes in highway and bridge engineering design standards since the original bridges were built in the early 1930s. For example: standard safe travel lanes are now generally 12 feet wide compared to 10 ft. widths currently on the existing bridge decks; pedestrian and bicycle lanes now require a separation barrier from the vehicle lanes; a median should exist between the two directions of vehicular travel; and shoulders to accommodate breakdowns would be needed.

Any new high-level bridge must also take into account the requirements for navigation of the Canal beneath the bridges. Currently the 1930s bridges have a vertical clearance of 135 feet above mean high water (MHW). The largest ships using the Canal today are auto carriers and cruise ships, many of which have designs that include 135-foot clearances.

Piers for the existing bridges are currently located within the Canal. New bridge piers would be relocated out of the water and onto land by approximately 50 feet on each side of the canal, which would require lengthening of the spans over the waterway.

The current bridges would remain open and continue to be inspected and maintained in a safe and reliable state while construction of the new bridges was underway. The current bridges would be dismantled after the new bridges have been opened to traffic.

The actual type, design and location of any proposed new bridge(s) will be determined and evaluated in Phase II of the Cape Cod Canal Bridges Project.

The Draft MRER/EA included this alternative among the alternatives considered in the detailed evaluation. Based on comments on the Draft MRER/EA provided by the FHWA and MassDOT, replacement of the Bourne and Sagamore bridges in-kind with respect to the number of through traffic lanes would not conform to current design guidance for bridges and highways and is therefore not a reasonable alternative. For this reason, providing new bridges without auxiliary lanes would not be consistent with best practices for traffic safety, and Plan C will not be carried forward into detailed analysis in the final EA.

FHWA and MassDOT reviewed the Draft MRER and EA and stated the following in their response letter:

"Based on the close proximity of the interchanges and intersections at the end of each bridge, current standards for this type of facility include acceleration and deceleration lanes (also known as auxiliary lanes) going onto the bridges in most, if not all, four ends of the bridges. In final design, analysis will need to be done to determine if the auxiliary lanes should be continuous across each bridge for operational weaving and structural efficiency needs pending on the structure type, long span bridges such as these may gain cost efficiency with a uniform width."

MassDOT stated the following with respect to the need for auxiliary lanes:

The design requirements used for the roadways, intersections, and interchanges shall be in accordance with and the 2006 MassDOT Project Development and Design Guide as well as 2018 American Association of State Highway and Transportation Officials (AASHTO) Policy on Geometric Design of Highway and Streets ("the Green Book"). See Chapter 10 of The Green Book which includes Tables 10-4 Minimum Acceleration Lane Lengths for Entrance Terminals…, Table 10-5 Speed Change Lane adjustment factors as a function of grade…, and Table 10-6 Minimum deceleration lane lengths for exit terminals…; these dictate the required lengths for this type of facility include acceleration and deceleration lanes (also known as auxiliary lanes).

5.2 Alternatives Evaluated

This EA presents a detailed analysis and comparison of three alternatives: Alternative (A) No Action; Alternative (B) Major Rehabilitation; and Alternative (D) Preferred Alternative - Bridge Replacement - 4 Lanes and 2 Auxiliary Lanes.

Detailed analysis of these alternatives including existing conditions and environmental consequences is provided in subsequent sections.

5.2.1 Alternative A – No Action (Without Project Condition

The No Action Alternative is the baseline against which the other alternatives can be evaluated.

Under the No Action Alternative, the USACE would continue to repair and maintain the two highway bridges as needed to maintain safety. Major rehabilitation efforts would not be conducted and components of the structures would be repaired and critical elements replaced as they deteriorate and before they fail. Under this option, without major rehabilitation, each bridge would ultimately reach a point where routine maintenance and minor component replacement would no longer yield acceptable design performance. At such a point, the bridges would need to be posted to limit the loaded weight of heavy vehicles in order to assure continued bridge safety. Lower vehicle load and speed limits would be posted in the future as the bridges continue to age.

Over time, this alternative would have escalating and significant impacts on vehicle traffic and the economy of the Cape and Islands as large trucks would need to be replaced by smaller ones. The cost of transporting goods onto and off the Cape would rise over time. More trucks and lower speeds would result in more frequent and lengthier traffic delays. Vehicle emissions would increase due to traffic delays and tourism would be impacted by these conditions.

5.2.2 Alternative B - Major Rehabilitation for Both Bridges

This alternative consists of major repairs and ongoing maintenance to both Canal bridges.

To maintain bridge safety and performance, and to avoid the need for future restrictions through vehicle weight postings and other safety measures, each bridge would need to undergo a major rehabilitation cycle within the next six years, and at least every 45 years thereafter. The ongoing program of continual inspection, maintenance, and repairs would also continue throughout the remaining life of the bridges.

Major rehabilitation involves significant repairs and replacement of major bridge components such as connections between the spans and the piers/abutments, hangers that help connect deck and truss sections, gusset plates that tie truss members together, and substructure members of the decks themselves. Each of these are major actions that would require partial or full closure of the bridges to traffic.

Major rehabilitation programs were undertaken for both highway bridges in the early 1980s and involved extensive repair and replacement of major bridge components such as cables, plates, and decking. These actions required partial closures of each bridge for significant periods resulting in traffic congestion and delays.

Each major bridge rehabilitation would be expected to take approximately 3 ½ years to complete and work would be performed in the off-season (late October through mid-May), as much as feasible.

5.2.3 Alternative D (Preferred Alternative) - Replacement of Both Highway Bridges with New Bridges – 4 Lanes and 2 Auxiliary Lanes

Under this alternative, new bridges would be constructed as described in Alternative C, next to existing bridges and to modern standards. The bridge decks would be widened to include two through lanes and one auxiliary lane each way.

6.0 AFFECTED ENVIRONMENT and ENVIRONMENTAL CONSEQUENCES

The Phase I Major Rehabilitation Evaluation Study is a decision document that analyzes current bridge conditions and compares major rehabilitation and replacement alternatives for the Bourne and Sagamore Bridges. This EA documents resources within the project area and considers potential impacts based solely on a conceptual bridge design and a preliminary estimated project area. Resources and potential impacts will be more fully defined and analyzed when the project moves to the design and construction phase (Phase II).

This chapter describes the resources located within the proposed project area as well as potential impacts to these resources by the proposed action.

6.1 Physical Resources

6.1.1 Land Use

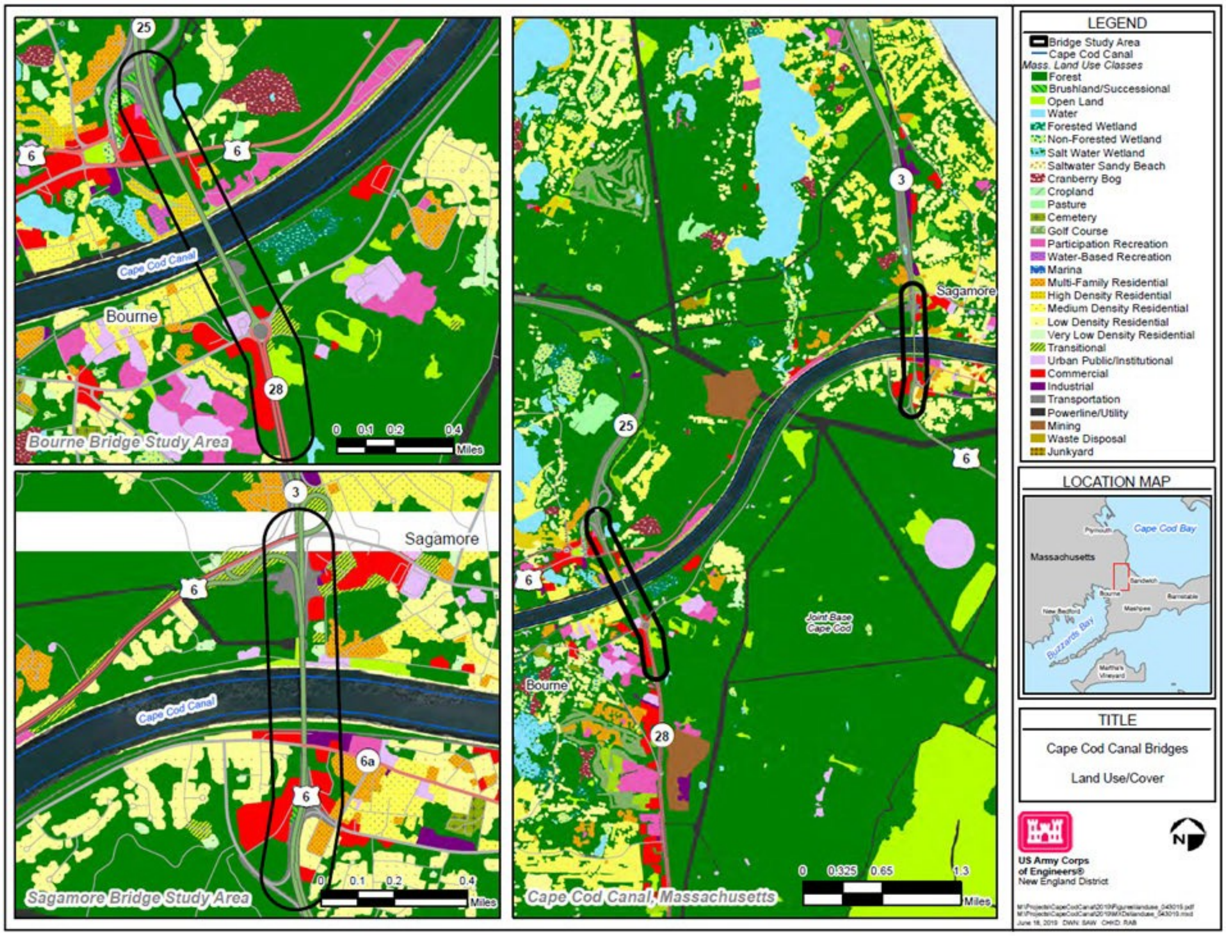
Property owned by the U.S. Government and administered by the USACE at the Cape Cod Canal includes a total of 1,153 acres; of which 982 acres of land is situated along the 7.7 mile land cut of the Canal. Approximately 20% of the government-owned property is developed. Within the developed areas are ten USACE-operated recreation areas.

The affected area is covered by transportation infrastructure, residential and commercial properties, and forested land (refer to Land Use Map – EA Figure 3). There is a large forested area east of the Bourne Bridge (Rt. 28) on the south side of the Canal bordered by Sandwich Rd., and both residential and commercial properties to the east bounded by Trowbridge Road. Immediately east of the Bourne Rotary are several commercial properties, including a gas station and hotel, and forested land on the eastern side of the rotary. On the northern side of the Canal, Nightingale Conservation Area and Nightingale Pond are located to the east of Rt. 25/Rt. 28, and are bordered by residential properties. There are commercial properties located to the west of Rt. 28 between the Bourne Rotary Approach and Rt. 6 which include Bourne Crossing Shopping Center and other businesses. There are a mix of residential properties and public conservation land adjacent to the Canal on either side of the bridge.

Around the Sagamore Bridge, there are commercial properties located east of Rt. 3 on the northern side of the Canal with a mix of land uses extending south of those commercial properties to the Canal. There is a forested area to the west of Rt. 3 on the northern side with several residential properties and a power line right-of-way. The southern shore of the Sagamore study area is a mix of residential and commercial properties on both sides of Rt. 6, which bisects this portion of the project area.

The Canal has riprap embankments along the shoreline with service roads running along both sides of the canal. This USACE property is used for Canal maintenance access as well as public recreational access.

EA Figure 3 – Land Use



Environmental Consequences

Alternative A – No Action

No changes would occur to existing land uses because with routine and emergency maintenance bridge alignments would remain the same, and no other changes to the bridges footprint would occur. There are no other foreseeable changes to land use or land cover related to the bridges remaining in their current position with no major changes to their configuration and function.

Alternative B – Major Rehabilitation for Both Bridges

Major rehabilitation of the bridges would cause temporary localized impacts from construction and maintenance activities, but the permanent bridge structures would all continue to occupy the same footprint. Past maintenance and rehabilitation efforts were completed without adverse effects to land use and physical resources. For example the 1981 major rehabilitation included bridge deck, side walk, steel, and concrete repairs, pavement replacement, and painting of the steel structure. Construction activities associated with major rehabilitation would require equipment storage and lay-down areas. The total acreage of potential temporarily impacted areas will be determined during the design and construction phase (Phase II) of the bridge project. The right-of-ways underneath the bridges are used in this capacity for the current joint replacement activities, and could continue to be used for construction equipment during a major rehabilitation. Any disturbed sites would be returned to pre-project conditions following the completion of major rehabilitation. All related activities would be fully evaluated once specific rehabilitation activities have been determined. Best management practices will be incorporated to avoid and minimize impacts whenever possible. Therefore, there would no significant adverse impacts to land use under Alternative B.

Alternative D (Preferred Alternative) – Replacement of Both Highway Bridges with New Bridges - 4 Lanes and 2 Auxiliary Lanes

Localized, permanent impacts adjacent to the existing highway bridges would occur where the replacement bridge would be constructed. The bridge piers, abutments, and landings would be in slightly different locations and thus result in permanent land use impacts. Exact bridge locations and specifications will be defined in Phase II. Under Alternative D, the footprints would be slightly larger because of the two auxiliary lanes on each bridge. The affected land uses by the new bridges under both alternatives are commercial, transportation, forested, and residential. The new Sagamore Bridge alignment would affect forested areas on the western side of the bridge and would move in closer proximity to the residential area on the southern side of the Canal, south of Sandwich Road. It would also cross over the utility right-of-way and substation west of the bridge on the northern side of the Canal. At the Bourne Bridge, the new alignment would be relocated to where there is currently a Dunkin Donuts at the Bourne Rotary, and would also affect the forested area between there and the Canal. On the northern shore of the Canal, the new alignment would cross over the forested area on the eastern side of the bridge. The construction staging areas would be returned to pre-project conditions where possible. Road networks connected to the bridges would likely change under future conditions in locations where the existing bridges are replaced. Therefore, effects on land uses from Alternative D are expected to be minor. The Massachusetts Department of Transportation has completed a *Cape Cod Canal Transportation Study* (MassDOT, 2019) with recommendations for infrastructure improvement projects based on replacement of both the Bourne and Sagamore Bridges, but this is only a conceptual planning study at this time. Potential impacts of these conceptual projects combined with bridge replacement projects are discussed in the *Cumulative Impacts* section of this EA.

6.1.2 Terrain and Topography

Barnstable County has rolling hills, with elevations ranging from sea level to 200 feet above mean sea level (msl) (MassGIS, 2019). There are numerous bogs, marshes, sand dunes, and ponds on the landscape. The terrain around the bridges has varied changes in elevation, generally rising with distance away from the Canal in the project area. Elevation in the study areas ranges from sea level to approximately 100 ft. above msl around the Sagamore Bridge, with an increase in elevation around the Bourne Bridge of 50 to 100 feet above sea level (MassGIS, 2019).

Environmental Consequences

Alternative A – No Action and Alternative B – Major Rehabilitation for Both Bridges
There would be no impacts to terrain and topography with routine bridge maintenance or major rehabilitation because no changes to existing grades are anticipated.

Alternative D (Preferred Alternative) – Replacement of Both Highway Bridges with New Bridges - 4 Lanes and 2 Auxiliary Lanes
Re-grading of some surrounding areas to accommodate the new bridge approaches and abutments will be required for new bridges. The project area has previously experienced filling and re-grading during the original construction of the existing bridges and highways, which was confirmed by soil analysis and consultation of historic topographic maps. However, until specific bridge designs are available, the exact extent of these modifications is unclear and will be fully defined in Phase II of the project. It is anticipated only minor impacts to Terrain and Topography would be expected under Alternative D.

6.1.3 Geology/Soils

The Cape is composed of glacial end moraines, which mark the approximate locations of the ice front and outwash plains formed by sediments deposited by streams of melt water from the glaciers. The result is a series of connected, broad, sandy plains and hilly terrain.
Sediments at the east end of the Canal were deposited in a lake that formed in the Cape Cod Bay between the retreating ice front and the Sandwich moraine. These glacial lake deposits are mostly well-sorted medium to fine sand, and in some places include a silt and clay layer that caps the sand. The principal outlet for the lake was formerly known as Monument Valley, the current site of the Cape Cod Canal. The Canal's main glacial features of moraine, out-wash plain and glacial lake deposits are comprised of six major soils and twenty-nine minor soils. A significant amount of Canal soils are Udipsamments, i.e. the original soil was excavated or filled during construction. The bedrock surface altitudes in the vicinity of the Canal range from roughly -125 to -175 feet msl (Fairchild et al 2013). There are 27 different soil types identified in the NRCS web soil survey (https://websoilsurvey.nrcs.usda.gov/app/WebSoilSurvey.aspx, Appendix G) for the project area. The three most dominant soil types by area within the study zone are Udisamments, smoothed; Plymouth loamy coarse sand, 3-8% slopes; and Urban land.

Environmental Consequences

Alternative A – No Action and Alternative B – Major Rehabilitation for Both Bridges
No impacts because the existing bridge structures would remain in place and only activities related to routine maintenance or rehabilitation of the existing structures would occur.

Alternative D (Preferred Alternative) – Replacement of Both Highway Bridges with New Bridges - 4 Lanes and 2 Auxiliary Lanes
Bridge replacement would have no long term effect on geology and soils. Surface soils in currently managed areas (road margins and adjacent urban development) may be disturbed by construction activities during the course of work on the bridge approaches and abutments and the creation of temporary laydown areas, and also for altering the configuration of approaches under Alternative D. No measurable impacts to geology and soils are anticipated for Alternative D.

6.1.4 Climate

The National Oceanographic and Atmospheric Administration (NOAA), National Centers for Environmental Information provides historic weather and climate data in their searchable online tools, accessible through the Climate Data Online (CDO) website. According to the data obtained, Barnstable County experiences average high temperatures ranging from 80 degrees Fahrenheit (°F) in July to 38°F in January and average low temperatures ranging from 63°F in July to 20°F in January. Average annual precipitation is 47.63 inches, with the month of March generally receiving the most precipitation and the month of July receiving the least (NOAA, 2016). Extreme weather varies in Barnstable County from drought conditions to hurricane events. Recent examples include the "advisory" level drought conditions observed in 2016 and the 1991 hurricane (named "Bob") which produced winds in excess of 100 miles per hour and spawned five associated tornadoes (Mass.gov, 2016).

Environmental Consequences

Alternative A – No Action, Alternative B – Major Rehabilitation for Both Bridges, and Alternative D (Preferred Alternative) – Replacement of Both Highway Bridges with New Bridges - 4 Lanes and 2 Auxiliary Lanes

None of these alternatives would have direct or indirect impacts to the climate of the region. Only short duration, minor discharges of carbon-based pollutants would occur during construction activities that could contribute to greenhouse gases. Routine operation and maintenance, replacing or rehabilitating existing bridges will not have any appreciable effects on climate in the region because of the limited potential of these activities to influence long term temperature and weather trends.

6.1.5 Sea Level Change

USACE policy requires an analysis of the potential effects of sea level change on a proposed project. Civil works projects must consider and evaluate future rates of sea level change (SLC), potential impacts, responses, and adaptations (ER 1100-2-8162). The New England District, Water Management Section, was tasked with assessing the potential for future sea level change within the Canal over the next 50 and 100 years to ensure adequate clearance under the Bourne and Sagamore bridges for navigational purposes.

The canal is 32 feet deep, 350-700 foot wide, and the Mean High Water is nearly 1.5 feet greater at the Sagamore Bridge than the Bourne Bridge (EA Table 1).

EA Table 1-Canal Tidal Datums in feet relative to Mean Sea Level

Water Level	**Railroad Bridge**	**Bourne Bridge**	**Sagamore Bridge**
Mean Higher High Water (MHHW)	2.18	2.52	3.93
Mean High Water (MHW)	1.81	2.14	3.56
North American Vertical Datum of 1988 (NAVD88)	0.57	0.57	0.56
Mean Sea Level (MSL)	0.0	0.0	0.0
Mean Tide Level (MTL)	0.10	-0.10	-0.17
Mean Low Water (MLW)	-1.60	-2.34	-3.89
Mean Lower Low Water (MLLW)	-1.85	-2.62	-4.20
Mean Range	3.41	4.48	7.45
Great Diurnal Range	4.03	5.14	8.13

Note: Water level datums obtained from NOAA's vDatum

The USACE examined three scenarios of sea level change at the project site: (1) historic rate, (2) intermediate rate, and (3) a high rate of sea level rise, to determine the potential impact to the bridge projects. Considering a project start date in 2025, the projected sea level changes after 50 and 100 years are predicted to be: 0.78 feet per year, 1.4 feet per year, and 3.34 feet per year by 2075; and 1.26 feet per year, 2.83 feet per year, and 7.82 feet per year by the year 2125. The full Sea Level Change analysis can be found in Section 7.2.2 of the MRER.

During Phase II of the project, the USACE will incorporate considerations for potential sea level change into the design analyses so both bridges can accommodate and withstand any projected sea-level change.

Environmental Consequences

Alternative A – No Action, Alternative B – Major Rehabilitation for Both Bridges, and Alternative D (Preferred Alternative) – Replacement of Both Highway Bridges with New Bridges - 4 Lanes and 2 Auxiliary Lanes

Based on the information above, none of these alternatives will be impacted by sea level change. For bridge replacement alternatives, the USACE will incorporate potential sea level change considerations into the design process during Phase II for both bridges to accommodate necessary vertical clearances for large vessel transit and maintain navigation through the Canal.

6.1.6 Air Quality

The Clean Air Act (40 CFR Part 50) requires U.S. Environmental Protection Agency (EPA) to set, and states to adopt, National Ambient Air Quality Standards (NAAQS). The standards have been established to protect the public from potentially harmful amounts of pollutants. EPA has set National Ambient Air Quality Standards (NAAQS) for the following six criteria pollutants: Carbon Monoxide (CO), Lead (Pb), Nitrogen Dioxide (NO2), Particulate Matter with a diameter less than or equal to ten micrometers (PM10) and less than 2.5 micrometers (PM2.5), Ozone (O3), and Sulfur Dioxide (SO2).

EPA has designated specific areas as NAAQS Attainment or Non-Attainment areas. Attainment areas are those areas that meet ambient air quality standards and non-attainment areas are areas that do not meet quality standards for a specific pollutant. If an area is designated as "nonattainment", states must develop a State Implementation Plan (SIP) as a pathway to attain and maintain the National Ambient Air Quality Standards (NAAQS) (EPA, 2019a).

Both bridge replacement projects are located within Barnstable County, which is currently designated as an Attainment Area for all National Ambient Air Quality Standards. EPA promulgated a transportation conformity rule (40 CFR Parts 51 and 93) pursuant to requirements of the Clean Air Act. The rule only applies in EPA-designated non-attainment or maintenance areas (40 CFR 93.102(b). The project area is in attainment of all of the applicable NAAQS; therefore, transportation conformity rule requirements do not apply for this region.

Lead Paint:
The existing paint system on both bridges contains lead paint. Even areas that have been previously maintained contain residual amounts of lead.

During a previous bridge rehabilitation project on the Sagamore Bridge (1981), old paint was sandblasted to prepare surfaces for repairing and repainting. As the result of this work, ambient concentrations of total suspended particulates (TSP) temporarily increased in the immediate vicinity of the sandblasting. The old paint contained lead. The USACE conducted air monitoring over a 10-month period to determine impacts to ambient air quality and to ensure there were no adverse effects on public health from the rehabilitation activities. There was no exceedance of lead or annual TSP standards throughout the entire monitoring period. Both lead and TSP concentrations were low in comparison to Federal and State ambient air quality standards (USACE, 1982).

Contract specifications and work requirements for painting of the Sagamore Bridge again in 1998 ensured that all work was performed in accordance with applicable environmental regulations and health and safety standards. Protective measures included BMPs such as proper surface preparation and removal of lead containing paint, shrouds and negative pressure work environments around sand blasting activities for containment, emissions monitoring, collection, and proper disposal of all lead containing paint debris (USACE, 1998).

Environmental Consequences

None of the Alternatives will result in permanent air emissions or long-term impacts to air quality providing BMPS are incorporated at the time of scheduled construction activities. No impact to local or regional air quality should occur as the result of the proposed project.

Alternative A – No Action and Alternative B – Major Rehabilitation for Both Bridges

Bridge routine and emergency maintenance, as well as major rehabilitation activities, have the potential to cause a temporary increase in air emissions due to traffic backups and delays associated with this work.

MassDOT conducted a preliminary air quality evaluation as part of their *Cape Cod Canal Transportation Improvements Study* (2019) to assess the potential for increased or decreased air quality impacts associated with their conceptual improvement projects. They examined modeled traffic impacts for "worst-case conditions" during summer peak traffic. They used carbon monoxide (CO) for their analysis of pollutant levels as it is the most abundant pollutant emitted by motor vehicles and can result in high concentrations in congested areas (MassDOT, 2019). The study concluded that increased traffic volumes and delays could result in an increase in CO emissions.

Routine maintenance and major rehabilitation will require removal of lead containing paint from both bridges. During the design and construction phase, a detailed monitoring plan will be developed in conjunction with both Federal (EPA) and state agencies according to applicable regulations and BMPs to identify and mitigate potential air and soil impacts from construction activities. Impacts to air quality under Alternatives A and B would be temporary during construction and would be considered minor.

Alternative D (Preferred Alternative) – Replacement of Both Highway Bridges with New Bridges - 4 Lanes and 2 Auxiliary Lanes

Over the short term, bridge replacement will not significantly affect regional air quality levels because existing bridges will remain open until new bridge construction is completed; therefore, the emissions from bridge traffic during construction would remain unchanged from existing conditions.

Short-term/temporary increases in emissions would occur during the construction period for new bridges. To reduce temporary impacts to air quality, construction contractors would be required to water down construction areas if necessary, keeping fugitive dust to a minimum.

Emissions from fuel-burning internal combustion engines during construction (e.g., heavy equipment and earthmoving machinery) would temporarily increase the levels of some of the criteria pollutants including CO, NO_2, O_3, PM10, and non-criteria pollutants, such as volatile organic compounds (VOCs). To reduce the emission of air pollutants, fuel-burning equipment running times would be kept to a minimum and engines would be properly maintained.

Short term impacts resulting from dust, construction vehicles, and related equipment are expected to be minor and should not have a significant impact on local air quality. To address short-term air quality impacts, specific mitigation measures will be listed in contract specifications and will be implemented during all construction activities.

Replacement of the existing bridges will also include demolishing the old bridges which may produce lead contaminated blast debris. All work will be performed in accordance with applicable environmental regulations, BMPs as well as worker health and safety standards, including containment, emissions monitoring, collection, and disposal of all contaminated blast debris and as such, there will be no significant impacts to air quality.

With respect to long term impacts, the MassDOT hired a contractor to prepare a qualitative evaluation of twelve intersections for both existing and future intersections and with and without the Bourne and Sagamore bridges being replaced. The potential effects of replacing the bridges on air pollutant emissions depends on the degree to which their replacement would affect the efficiency of the flow of traffic and whether the increase in efficiency would result in an increase in overall traffic volume. An apparent effect of replacing the bridges would be to reduce travel durations over the bridges, which would reduce idling during peak transit time periods when congestion normally occurs and reduce overall air pollutant emissions. The MassDOT traffic study concluded that replacing the bridges and associated intersection upgrades would not significantly reduce travel times onto and off of Cape Cod because of bottlenecks to traffic flow that are located on the downstream of the bridges. Therefore, replacement of the bridges with more efficient vehicle lanes would not substantially affect the overall broad scale distribution or quantity of traffic-related air pollutant emissions. The MassDOT air quality evaluation assessed the potential for increased or decreased air quality impacts within the study area utilizing EPA and FHWA guideline criteria. Based on their analysis, minor increases in emissions of CO and Mobile Source Air Toxics, VOCs, and NOx could result from the bridge replacement, but given the relatively small expected average daily traffic increase of 1.5 to 2.0 percent relative to the total vehicle miles traveled in the region, it is unlikely the project would result in a substantial change in emissions. The report indicated that regardless of whether the bridges are replaced, future vehicle emissions would likely be lower than present levels because of the EPA's national air quality control programs mandated under the federal Clean Air Act (MassDOT, 2019). The MassDOT preliminary air quality evaluation can be viewed in Appendix E.

MassDOT plans on conducting additional air quality analyses in the next phase of the project to evaluate existing and future air quality impacts associated with the bridges and associated roadways. Impacts would be assessed with respect to the methodologies and assumptions for each pollutant consistent with FHWA and EPA guidance as well as that of the MassDOT and Massachusetts Department of Environmental Protection (MassDEP) (MassDOT, 2019).

6.2 Water Resources

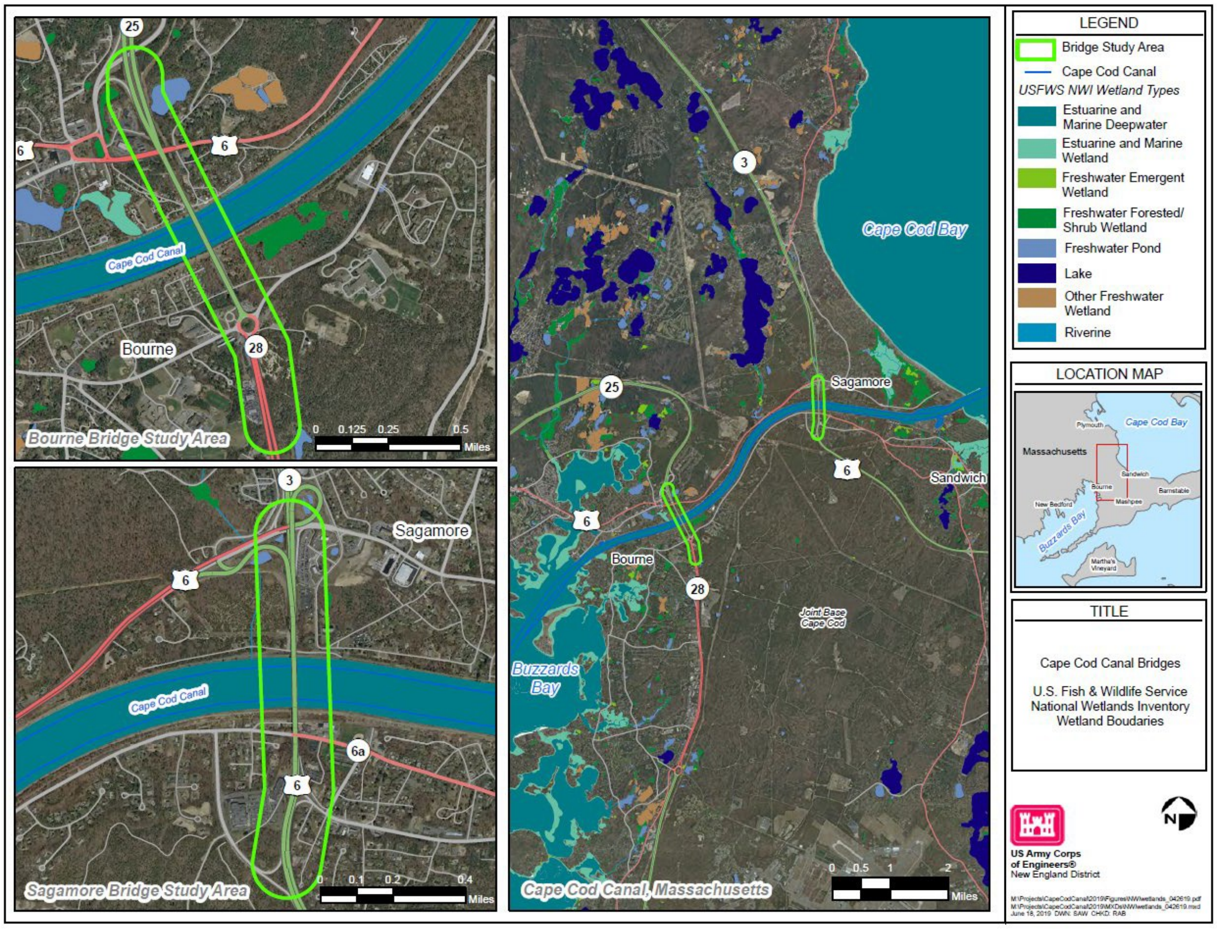
6.2.1 Surface Water and Wetlands

The Cape Cod Canal FNP connects Buzzards Bay and Cape Cod Bay, and has significant tidal exchange with those water bodies. On land, surface water resources on the Cape include freshwater wetlands, salt marshes, bogs, and ponds. Large streams do not exist on Cape Cod because of the high permeability of the Cape's sandy soils. Precipitation that does not evaporate or get transpired by plants infiltrates into the ground with little direct surface runoff. Much of the groundwater on the Cape discharges directly to coastal waters and embayments (USGS, 1999). There are many freshwater ponds on the Cape, most of which are located in kettle holes on the glacial outwash plain. Many naturally-occurring ponds on Cape Cod are flow-through ponds where water flows directly from the upgradient pond to recharge the aquifer on the downgradient side (Walter et al, 2004). The project area has several man-made ponds and freshwater wetlands.

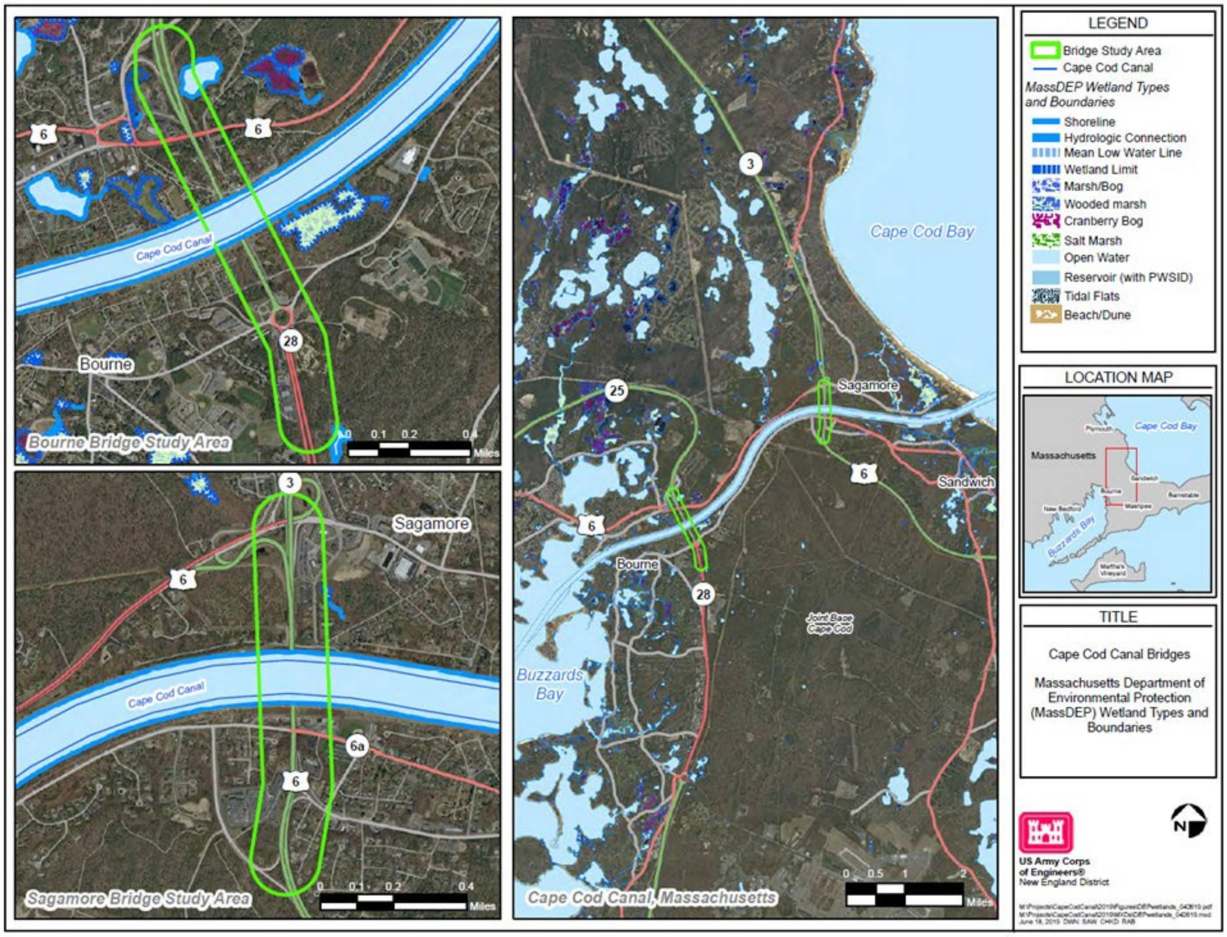
The largest water body located within the project area is the seven acre Nightingale Pond, located on the northwestern corner of the Bourne Bridge Study Area. There are four small ponds located within the existing approach to Sagamore Bridge, and two small ponds to the north of the study area that would also be affected by bridge construction and maintenance activities. Based on their location nestled within the roadways (See EA Figure 4 - Wetlands), the ponds were likely excavated for fill used to construct the bridge approaches and roads. None of these ponds are displayed on the historic USGS topographic map of the area, which was surveyed in years (1932, 1933, and 1937) prior to the 1938 construction of the current bridges There is also a small forested wetland approximately 200 feet east of Canal Rd. on the eastern side of the northern Sagamore Bridge approach.

The ponds in EA Figure 4 - Wetlands, all of which are less than a half-acre in size, are surrounded by the roadways of the Sagamore Bridge approach. The slope and topography of this area indicate these ponds drain the land within the approach, which are at a higher elevation than the surrounding natural landscape.

EA Figure 4 - Wetlands



EA Figure 5 - MassDEP Wetlands



The U.S. Fish and Wildlife Service's National Wetlands Inventory (NWI) shows forested wetlands in the Bourne Bridge area (See EA Figure 4 - Wetlands).There are two forested freshwater wetlands between Rt. 6 and the Bourne Bridge approach, and another on the southern shore of the Canal roughly 700 feet east of the bridge. Finally, there is an area of estuarine marsh between the bridge and Old Bridge Rd. on the northern shore of the Canal. The Massachusetts Department of Environmental Protection (MADEP) identifies one additional forested wetland on the eastern land-ward side of the Sagamore Bridge study area, <0.3 acre, however, this is located outside of the study area. EA Figure 5 shows wetlands identified by the Massachusetts Department of Environmental Protection (MADEP). A USACE field inspection conducted on April 15, 2019 confirmed the location of wetlands found in the online databases. An additional area of forested wetland approximately 50 by 100 feet in size (0.5 acres), is located roughly 500 feet east of the Bourne Bridge on the northern shore of the Canal. This wetland was composed of open water and red maple trees growing on hummocks. The wetland was bordered vy very thick greenbrier. It is bordered on the northeast by railroad tracks and on the southeast by uphill slopes with white pine. The survey took place before the height of the growing season, so understory herbaceous plants had not yet emerged and a full botanical survey was not completed.

This wetland is located alongside the railroad tracks that run along the Canal shoreline. The tracks apparently impound water as it flows down-slope toward the Canal, thus creating a forested wetland where water would otherwise infiltrate the sandy soils and flow directly towards surface water bodies.

The Herring River Watershed is located west of the Sagamore Bridge study area on the mainland side of the Canal. This watershed is designated by the state as an Area of Critical Environmental Concern (ACEC) for its importance to anadromous fish and other wildlife.

Environmental Consequences

Alternative A – No Action and Alternative B – Major Rehabilitation for Both Bridges
There would be no impacts to surface water and wetland resources because activities would take place only around existing structures where no wetlands are identified. Thus, only the area of the Canal where the piers are currently situated would continue to have impacts from routine maintenance or major rehabilitation, as well as by the presence of construction support barges in the event they might be required. Routine maintenance or major rehabilitation in the future would not involve any wetland impacts outside of the Canal.

Alternative D (Preferred Alternative) – Replacement of Both Highway Bridges with New Bridges - 4 Lanes and 2 Auxiliary Lanes
Nearby wetlands and ponds may be temporarily affected by construction activities. No adverse impacts are expected for the ACEC and Nightingale Pond, and construction best management practices would mitigate any potential indirect effects from construction-related runoff. The most prominent surface water feature that would be affected is Nightingale Pond in the Bourne Bridge study area. The new proposed alignment would abut the western edge of that pond. Mitigation measures to protect the pond would be developed when the new bridge designs are finalized during Phase II of the project. The Canal shoreline would also receive new proposed bridge piers, as they would be relocated out of the water. The shoreline in this area is rock/riprap, and is located on USACE property. The forested wetland 500 ft. east of the Bourne Bridge on the northern side of the Canal touches the easternmost boundary of the area affected by the new alignment. This half-acre wetland would be most impacted under Alternative D, because of the extra width imposed by the auxiliary lanes. The USACE will evaluate the effects to regulated wetlands and water resources through a Clean Water Act, Section 404(b)(1) evaluation and will obtain State Water Quality Certification for any discharge of fill material into waters of the United States. Mitigation measures will be developed during the design phase for any impacts to this wetland as a result of Alternative and D. If there are any impacts to wetlands as a result of the project, wetlands will be restored either within the Federal navigation project or at an appropriate site in the vicinity of the project. Therefore, Alternative D could have moderate impacts to wetlands, but with appropriate mitigation would be minor.

6.2.2 Water Quality

Water quality is considered for both fresh and salt water resources in the project area. The saltwater environment in the Canal is subject to the diurnal tidal cycle in connection with Cape Cod Bay and Buzzards Bay, creating a swift current that can reach 5.2 mph during the ebb tide

(USACE, 2017). Water quality in the Canal is affected by the large volume of maritime traffic that passes through on a daily basis. The Massachusetts Department of Environmental Protection designates the Canal as “Class SB,” meaning that the waters of the Canal are designated for fish, other aquatic life and wildlife, and for primary and secondary contact and recreation (DeCesare and Connor, 2002). Surface water on land is affected by runoff from the urban landscape and high volume of road traffic that passes over the Canal bridges.

Nitrogen pollution from residential septic systems is a major concern on the Cape, as it can travel quickly through groundwater into ponds and coastal waters, causing algal blooms that negatively affect marine life (Dunn, 2018). Nitrogen pollution can also be exacerbated through stormwater runoff. The Cape Cod Commission notes that the number of public drinking water wells tested as “very clean” for nitrate levels has dropped from 57% to 42% from 1993 to 2008.

Environmental Consequences

Alternative A – No Action

There would be no impacts to water quality because there would be no change to existing conditions around the bridges. Routine maintenance operations would require construction activity on-site, but these operations have occurred for decades with no adverse water quality impacts. Therefore, no impacts to water quality are anticipated in the future under this alternative. Future increases in nitrogen pollution from residential septic systems are unrelated to the standard operation and maintenance of the bridges under any of the alternatives considered in this document.

Alternative B – Major Rehabilitation for Both Bridges

Major rehabilitation would have no impacts on water quality. Construction activities taking place in Alternative B would be implemented with the appropriate best management practices to minimize runoff that could impact water quality.

Alternative D (Preferred Alternative) – Replacement of Both Highway Bridges with New Bridges - 4 Lanes and 2 Auxiliary Lanes

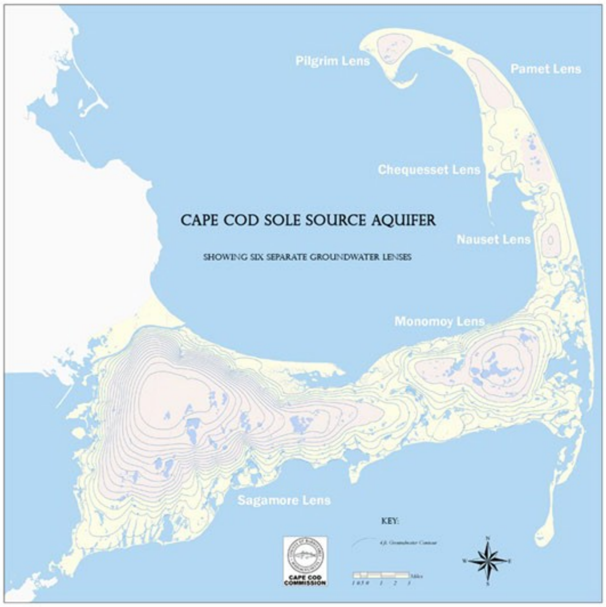
Replacement as authorized is not anticipated to have any substantial effect on water quality because impacts to regulated water resources would be minimized through avoidance and minimization during the design and construction phase. The USACE will evaluate the effects to regulated wetlands and water resources through a Clean Water Act, Section 404(b)(1) evaluation and obtain State Water Quality Certification for any discharge of fill material into waters of the United States. Water quality is a salient issue because of the high rate of infiltration in the Cape’s highly permeable soil and the fact that the project area is located in the vicinity of the Cape Cod sole source aquifer, discussed in the groundwater section of this EA. Appropriate measures to avoid and minimize impacts from construction activities to water quality will be developed during the design and construction phases. Measures to avoid or minimize impacts to water quality include the installation of silt fences and straw bales around worksites, placement of coir logs on slopes, containment of soil or sediment stockpiles if they need to be stored onsite, avoidance or setback distance from sensitive areas, and any other project-specific minimization measures as appropriate.

6.2.3 Groundwater

Regional groundwater occurs in alluvial and bedrock aquifers. The Cape Cod Aquifer is a bedrock aquifer (See EA Figure 6 - Cape Cod Sole Source Aquifer) and is designated as the principal source of drinking water for residents of Cape Cod. In 1982, the U.S. Environmental Protection Agency (EPA) designated the Cape Cod Aquifer as a Sole Source Aquifer. This designation means that the Aquifer supplies at least 50 percent of the drinking water consumed in the area above it. The regional water bearing units of the Cape Cod Aquifer are generally comprised of contiguous and permeable sandy substrates. Groundwater is the most important freshwater resource on the Cape (DeCesare and Connor, 2002). The aquifer is recharged solely from precipitation at 27 inches per year (Cape Cod Commission, 2017).

The glacial sediments that underlie Cape Cod form an unconfined aquifer with six hydrologically distinct flow lenses, the largest of which is the Sagamore Lens (Walter et al, 2004). The Sagamore Lens has 60% of the total 450 million gallons per day flowing through the entire Cape Cod aquifer (ibid). The western edge of the Sagamore lens underlies the study area in the town of Bourne, and the top of that lens is 69 feet above msl and located well outside of the project area to the southeast (Cape Cod Commission, 2017).

EA Figure 6 – Cape Cod Sole Source Aquifer



Environmental Consequences

Alternative A – No Action

There would be no impact to groundwater because no actions would occur that could affect regional or local groundwater patterns.

Alternative B – Major Rehabilitation for Both Bridges

There would be no impact to groundwater under Alternative B. These actions would not affect the Cape's high rates of surface water infiltration, and the effects of construction activities would not change the underlying hydrogeology of the area either directly or indirectly by rehabilitating the bridges.

Alternative D (Preferred Alternative) – Replacement of Both Highway Bridges with New Bridges - 4 Lanes and 2 Auxiliary Lanes

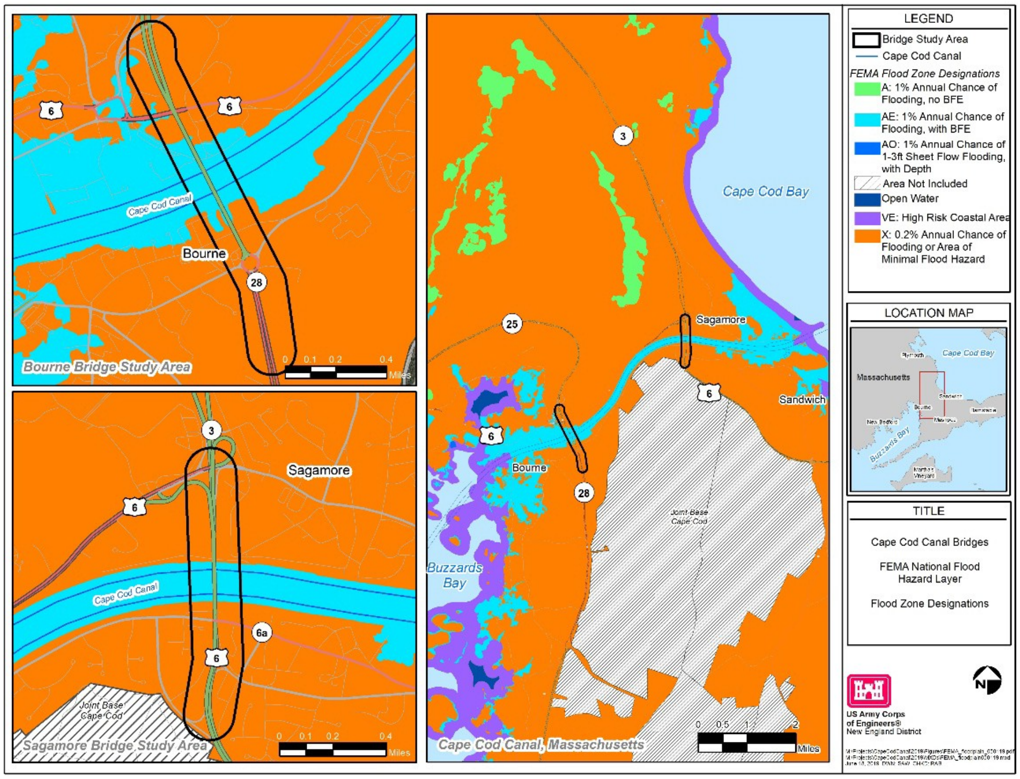
There would be no impact to groundwater under Alternative D because no actions would occur that could affect regional or local groundwater patterns. Replacing the bridges would not alter region-wide patterns of surface water infiltration to the aquifer because the work is confined to a relatively small area compared to the size of the Sagamore lens, and also located on the Western edge where the aquifer is deep and bordered by saltwater. Because of the high rate of soil infiltration of surface water, appropriate best management practices to minimize runoff would be implemented during the construction phase.

6.2.4 Floodplains

Executive Order (EO) 11988 (Floodplain Management) requires Federal agencies to avoid direct or indirect support of development within the 100-year floodplain whenever there is a practicable alternative. The Federal Emergency Management Agency (FEMA) National Flood Insurance Program (NFIP) publishes maps identifying areas at risk from potential flooding. The flood risk information is based on historical, meteorological, hydrologic and hydraulic data. Flood hazards are identified for areas subject to inundation by 100 and 500 year storm events.

Consistent with EO 11988, flood maps were examined during the preparation of this EA (EA Figure 7). The bridges are located in two zones:
X: 0.2% Annual Chance of Flooding or Area of Minimal Flood Hazard (500 year floodplain)
AE: 1% Annual Chance of Flooding, with Base Flood Elevations (100 year floodplain)

EA Figure 7 - Floodplain


LEGEND
Bridge Study Area
Cape Cod Canal
FEMA Flood Zone Designations
A: 1% Annual Chance of Flooding, no BFE
AE: 1% Annual Chance of Flooding, with BFE
AO: 1% Annual Chance of 1-3ft Sheet Flow Flooding, with Depth
Area Not Included
Open Water
VE: High Risk Coastal Area
X: 0.2% Annual Chance of Flooding or Area of Minimal Flood Hazard
LOCATION MAP
Massachusetts
Cape Cod Bay
Buzzards Bay
TITLE
Cape Cod Canal Bridges
FEMA National Flood Hazard Layer
Flood Zone Designations
US Army Corps of Engineers® New England District
Bourne Bridge Study Area
Sagamore Bridge Study Area
Cape Cod Canal, Massachusetts
Cape Cod Canal
Bourne
Sagamore
Sandwich
Cape Cod Bay
Buzzards Bay
Joint Base Cape Cod
6
28
3
25
6a
0 0.1 0.2 0.4 Miles
0 0.5 1 2 Miles

Environmental Consequences

Alternative A – No Action, Alternative B – Major Rehabilitation for Both Bridges, Alternative D (Preferred Alternative) – Replacement of Both Highway Bridges with New Bridges - 4 Lanes and 2 Auxiliary Lanes

There will be no significant impact to, or alteration of, floodplains or flood levels associated with any of the alternatives as the both bridges are located within an existing federal navigation channel and adjacent to developed land.

6.3 Coastal Resources

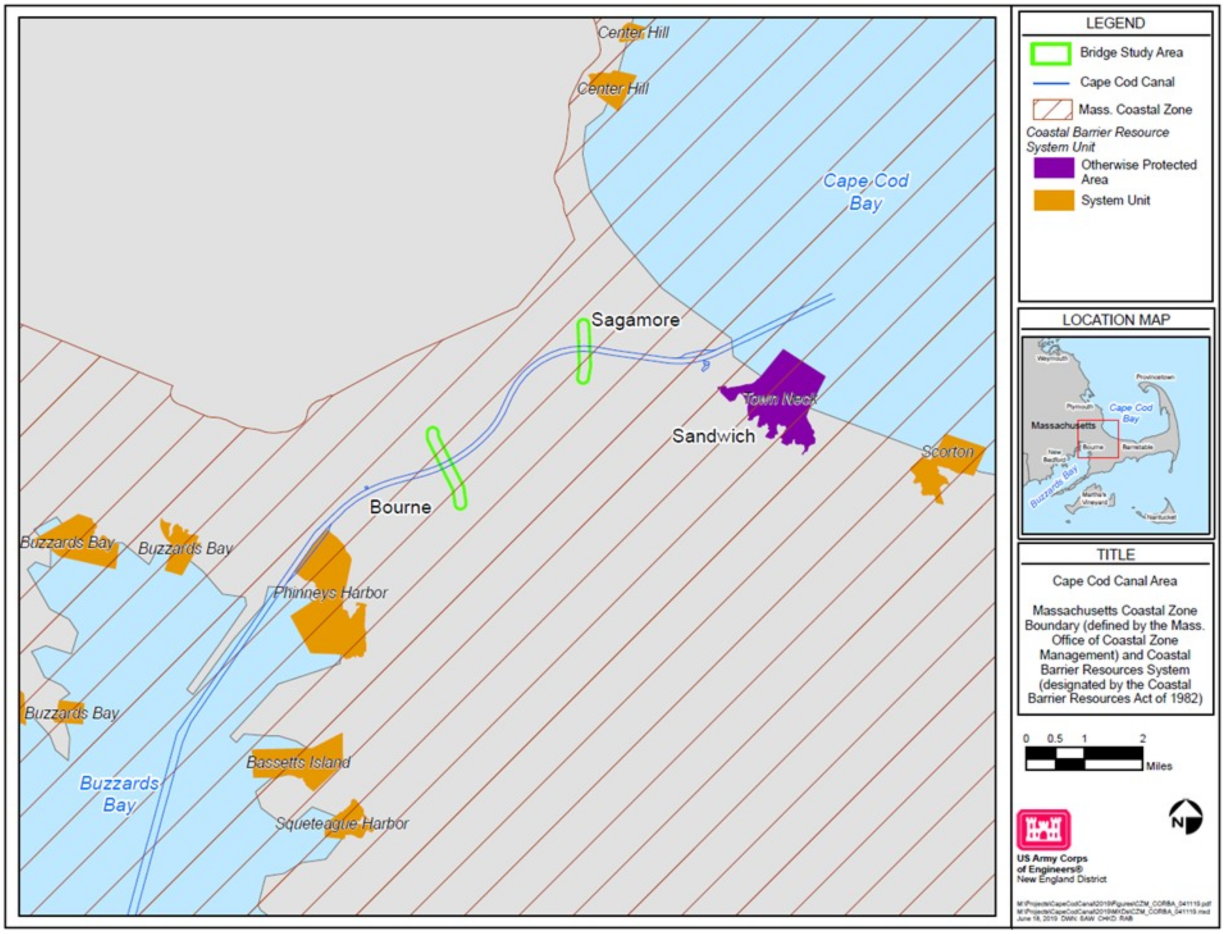
6.3.1 Coastal Zones

The Coastal Zone Management Act (CZMA) enables coastal States, including Massachusetts, to designate State coastal zone boundaries and develop coastal management programs to improve protection of sensitive shoreline resources and guide sustainable use of coastal areas.

Section 307 of CZMA requires federal agencies to determine if their federal actions might have reasonably foreseeable effects on any coastal use (land or water) or natural resource of the coastal zone, and are consistent with the enforceable policies of a state's federally-approved coastal management program. The Massachusetts Office of Coastal Zone Management implements the federal consistency review process in Massachusetts. Federal consistency review is required for most projects that: 1) are in or can reasonably be expected to affect a use or resource of the Massachusetts coastal zone, and/or 2) require federal licenses or permits, receive certain federal funds, are a direct action of a federal agency, or are part of outer continental shelf plans for exploration, development, and production (MA CZM, 2019)

All of Cape Cod and the islands of Nantucket and Martha's Vineyard are included in the Massachusetts coastal zone boundary. Both the Sagamore and Bourne bridge project areas are located within these coastal boundaries (EA Figure 8).

EA Figure 8 – Coastal Zone and Coastal Barrier Resources



Environmental Consequences

Alternative A – No Action and Alternative B – Major Rehabilitation for Both Bridges

Under the No Action and Major Rehabilitation alternatives, no new construction would occur within the coastal zone and activities associated with repair or rehabilitation of the existing bridges would not result in any short or long-term impacts to coastal resources within the project area.

Alternative D (Preferred Alternative) – Replacement of Both Highway Bridges with New Bridges - 4 Lanes and 2 Auxiliary Lanes

It is anticipated that bridge replacement will include the removal and re-location of existing support structures and piers within the canal to an upland setting, reducing the overall project footprint in the Canal itself. The piers from the old bridges will also be removed from the canal waters following completion of the newly constructed bridges thus reducing the overall footprint in subtidal areas. The shoreline where the piers are currently situated are shallow areas hardened with rip-rap for operation and maintenance of the Canal. Impacts during removal activities will be temporary and localized in nature and will reduce the in-water footprint of the bridges structures.

The Herring River Area of Critical Environmental Concern (ACEC) abuts the northwestern corner of the project footprint of the Sagamore replacement bridge. The USACE will utilize Best Management Practices (BMPs) during construction activities and throughout the entire removal process to minimize and avoid impacts to the surrounding coastal environment. The USACE will coordinate with the appropriate regulatory authorities during the design and construction phase of the project to ensure there will be no impact to the ACEC from replacement of the existing bridge structures.

Replacement of the two existing bridges will have no significant impact on the coastal environment. The project will preserve all coastal resources including the immediate waterfront for both recreational and vessel-related activities._ The USACE has determined that the proposed action is consistent with relevant policies of the coastal zone program. A Federal Consistency Determination has been submitted to the Massachusetts Office of Coastal Zone Management for concurrence on Phase I of this project. (Appendix H). Coordination with MA CZM will continue throughout all phases of the project to ensure consistency with the relevant policies of the coastal zone program. When the project enters the design and construction phase (Phase II), an additional Consistency Determination will be submitted to ensure that activities taking place within the coastal zone are consistent with state regulations protecting coastal features. Specific details of the bridge design, construction methods, and location will be identified for the Phase II submission.

6.3.2 Coastal Barrier Resources System

Coastal barriers are unique landforms that protects coastal mainland areas from severe coastal storm damage and erosion and are important wildlife habitat and recreational areas. The Coastal Barrier Resources Act (CBRA) of 1982 established the John H. Chafee Coastal Resources System (CBRS), which includes undeveloped coastal barriers along the Atlantic, Gulf of Mexico, Great Lakes, U.S. Virgin Islands, and Puerto Rico.

The Coastal Barrier Resources System contains two types of units, System Units and Otherwise Protected Areas (OPAs). OPAs are typically conservation and recreation areas such as national wildlife refuges, state parks, national parks, or local conservation areas. Section 5 of CBRA prohibits new federal expenditures or financial assistance for projects located within System Units such as road construction, channel dredging, coastal engineering projects which might encourage development or modifications of the coastal barriers. The only federal spending prohibition within OPAs is on federal flood insurance.

The Bourne and Sagamore Bridges project areas are located outside of CBRA System Units and Otherwise Protected Areas. (EA Figure 8).

Environmental Consequences

Alternative A – No Action, Alternative B – Major Rehabilitation for Both Bridges, and Alternative D (Preferred Alternative) – Replacement of Both Highway Bridges with New Bridges - 4 Lanes and 2 Auxiliary Lanes

There is no impact to coastal barrier resources as all alternatives are located outside of the Coastal Barrier Resources System.

6.4 Biological Resources

6.4.1 Vegetation

Cape Cod is situated in the Atlantic Coastal Pine Barrens ecoregion, a globally rare habitat type that only exists on the Cape and Islands, Long Island, and New Jersey (USGS, 2003). The 2017 Environmental Assessment and Finding of No Significant Impact for the Cape Cod Canal Photovoltaic Installation (USACE, 2017) documented land cover and vegetation for areas adjacent to the Sagamore Bridge and the nearby Midway Recreation Area, providing an overview of vegetation and land cover within the canal bridges study area and the surrounding landscape. The study area was historically a pine barren, dominated by pitch pine (*Pinus rigida*) with bear oak (*Quercua ilicifolia*), black oak (*Q. velutina*) and white oak (*Q. alba*) on sandy soils. Other abundant tree species include red maple (*Acer rubrum*), American white cedar (*Thuja occidentalis*), and American beech (*Fagus grandifolia*). The understory is characterized by plants such as bayberry (*Myrica* sp.), beach rose (*Rosa rugosa*), *Aster* sp., goldernrod (*Solidago* sp.), sweet fern (*Comptonia peregrine)*, sheep laurel (*Kalmia angustifolia*), and staghorn sumac (*Rhus typhina*). There are also invasive species such as spotted knapweed (*Centaurea stoebe*), autumn olive (*Elaeagnus umbellate*) and oriental bittersweet (*Celastrus orbiculatus*) present.

The MA land cover dataset (See EA Figure 3 - Land Use in section 6.1 of this document) shows the mosaic of transportation infrastructure, forested land, and residential/commercial development that occurs in both project areas around the Bourne and Sagamore bridges. There are patches of forested land in the study area, composed of oak-pine and scrub-oak communities. Forested areas occur within 1000 feet of both bridges, and these are interspersed among roads and development. On the north shore of the Canal to the west of the Sagamore Bridge approach, there is a 24 acre area of scrubby pineland, with an increasing hardwood component on the northwestern end near Rt. 6. To the east, there is an 11 acre patch of mixed pine-hardwood forest between Canal Road and Hunters Brook Road. On the southern shore in the Sagamore Bridge study area, there are small woody patches mixed in with low-density residential and commercial development.

To the east of the Bourne Bridge approach on the south shore of the Canal, there is a 45 acre patch of mixed pine-hardwood forest separated from the project area by a low density residential area and access road. There is also ample tree cover both east and west of the Bourne Bridge approach on the north shore, but inspection of aerial imagery reveals this is low density residential development and park segmented by roads, and not a contiguous area of forest. There is also a recreation area on USACE property. There are small patches of forest occurring between the roads entering Bourne Rotary Circle, as well as an area of mixed forest and commercial development southwest of the circle.

The shorelines of the Cape Cod Canal are primarily rip rap, and above that hard shoreline is a grassy area with occasional tree cover on the transition zone between the water and Canal Service Roads for both bridges. This is a man-made, heavily managed shoreline used for recreation and navigation purposes.

Environmental Consequences – Vegetation

Alternative A – No Action

There would be no impacts to vegetation as no changes to existing conditions would occur with this Alternative. Routine maintenance activities may have small impacts to roadside vegetation, but best management practices within construction zones would mitigate any peripheral impacts.

Alternative B – Major Rehabilitation for Both Bridges

Some disturbance of roadside vegetation would occur with major rehabilitation of bridges, but the impacts would be minimal because the scope of work is largely confined to the existing right-of-ways. Construction activities, such as use of lay down areas and equipment storage, may temporarily impact vegetation. This area of impact would be minimal due to the use of existing roads and infrastructure and barge-supported cranes for routine maintenance. The MRER does not include a full design component, so the exact logistical needs for construction equipment would be defined in Phase II of this project if major rehabilitation were the selected plan. Past maintenance and rehabilitation events have successfully been completed without adverse impacts to local vegetation. For example, the 1981 major rehabilitation included bridge deck, side walk, steel, and concrete repairs, pavement replacement, and painting of the steel structure. Therefore, minimal temporary impacts to vegetation are anticipated for Alternative B.

Alternative D (Preferred Alternative) – Replacement of Both Highway Bridges with New Bridges - 4 Lanes and 2 Auxiliary Lanes

There would be localized permanent impacts on vegetation where the bridge approaches, piers and abutments are relocated. Forested areas adjacent to the bridges would undergo permanent changes as outlined in the Land Use section of this document. A new bridge would be constructed immediately to the east of the Bourne Bridge, and another bridge immediately to the west of the Sagamore Bridge. Therefore, overall impacts to vegetation are expected to be moderate.

The precise dimensions of the new bridges will be developed in Phase II of the project. The existing bridges would be torn down and it has not yet been determined what would take place on the managed right-of-ways underneath those bridges. At both bridge sites, there are approximately 65 acres of tree cover within the entire 500 foot buffer zone of the existing bridge centerlines. This entire area would not be affected because the actual footprint of the new bridges is much smaller than the study zone for this phase of the project. Pitch pine, white pine, scrub oak, and red maple are examples of common species in the project area that would be permanently affected by Alternative D, and mitigation measures will be developed in Phase II when the full extent of impacts to vegetation become clear. Of the 65 acres of tree cover identified within the conceptual buffer area, 3 to 15 acres could potentially be impacted by construction of replacement bridges in Alternative D. We estimated the approximate magnitude of the direct impact of the new bridges on vegetation by estimating the percent increase in the size of the bridges and approaches and overlaying that conceptual footprint on the potential bridge touch down locations.

The potential impact for Alternative D is approximately 45% larger than the existing bridges, and the potential range of vegetation area impacted is 3 to 15 acres for Alternative D. These figures are based on a rough estimation of the potential area encompassing the replacement bridges. Bridge features, touchdown areas, location of work areas, construction equipment staging areas, and any associated mitigation measures will be identified during the design phase.

6.4.2 Wildlife

Mammals: There are a variety of mammals on Cape Cod inhabiting the diverse landscape, from the coastal pine barren forests to seashore environments. These include white footed mice (*Peromyscus leucopus*), deer (*Odocoileus virginianus*), and the North American river otter (*Lontra Canadensis*). Mammals on Cape Cod were affected by habitat conversion in the early 19th century from woodland to farmland, and there was some recovery when agriculture moved westward. Some species such as deer and beaver were actively restored by re-stocking, while others slowly recolonized naturally. In recent decades, otters have reappeared in the Cape Cod National Seashore and have become fairly common across the Cape. Black bear and bobcat have recently made forays back onto Cape Cod. In contrast, the woodchuck, which depends on open fields, has been in decline (NPS, 2012).

Several small terrestrial mammals potentially use the habitat areas surrounding the Bridges. These species include: striped skunk (*Mephitis mephitis*), eastern cottontail rabbit (*Sylvilagus floridanus*), eastern grey squirrel (*Sciurus carolinensis*), white-footed mouse, eastern chipmunk (*Tamias striatus*), American red squirrel (*Tamiasciurus hudsonicus*), and raccoon (*Procyon lotor*).

Birds: The Canal is an important corridor for birds traveling between Massachusetts Bay and Buzzards Bay. The bird-watching website Ebird.org lists several “birding hotspots” located around the Cape Cod Canal, where hundreds of different bird species have been observed (eBird.org, 2019). Barnstable County, MA, where the project is located, has the highest number of reported species (429) of any county in Massachusetts (eBird.org 2019b).

Birds that may utilize the project sites include sparrows (Family: Emberizidae), American robins (*Turdus migratorius*), crows (*Corvus* spp.), warblers (Family: Parulidae & Peucedramidae), blue jays (*Cyanocitta cristata*), and mallards (*Anas platyrhynchos*). Double-crested cormorant (*Phalacrocorax auritus*) and Great blue heron (*Ardea herodias*) have been reported (ebird.org 2019), as well as numerous coastal and sea-dependent bird species passing through the area. The USACE has implemented programs to increase use of the Canal by birds such as ospreys (*Pandion haliaetus*) and screech owls (*Megascops asio*). There are at least five osprey nesting platforms installed on utility poles on government land along the Canal. These platforms provide nesting opportunities for ospreys in order to encourage reproduction. To increase breeding opportunities for screech owls, nesting boxes were installed in the woodland west of the Sagamore Bridge. One pair of nesting ospreys occupied one of the constructed platforms within a few months of installation, and screech owls have been recorded using the nesting boxes.

Piping plovers (*Charadrius melodus*), red knot (*Calidiris canatus*), and roseate terns (*Sterna dougallii*) may also use the study area in a migratory or transient capacity, and they are discussed further in the section on federally-threatened and endangered species in this document.

Environmental Consequences

Alternative A – No Action

There would be no impacts to wildlife under the no action alternative because existing conditions would continue. Routine maintenance activities have not negatively impacted bird and other mammal populations around the bridges in the past and are not expected to do so in the future.

Alternative B – Major Rehabilitation for Both Bridges

There may be minimal, temporary effects on wildlife because of the noise and duration of construction activities associated with major rehabilitation. However, these impacts are not expected to be significant because the noise from construction vehicles will likely deter animals from the construction site. Birds would continue to be able to use the site for roosting and shelter, but would likely vacate the bridges due to disturbance from the construction activities, but may return once those actions cease. The bridges are currently a major thoroughfare with a high volume of traffic, so the increase in disturbance from major rehabilitation-related construction will not significantly alter the quality of existing wildlife habitat. Coordination with resource agencies in Phase II will establish any necessary best practices to protect bird and mammal populations in the project area.

Alternative D (Preferred Alternative) – Replacement of Both Highway Bridges with New Bridges - 4 Lanes and 2 Auxiliary Lanes

Impacts to wildlife are possible because of the changing footprint of new bridges, including the relocation of the piers from within the Canal to an upland setting, as well as extending the approaches. These changes would take place in the regularly-dredged Canal and existing network of transportation infrastructure around the bridges. The piers would be moved to an upland setting that is already mowed and maintained by the USACE. Wooded upland habitat used by wildlife would be affected, as well as marine epifauna living on the bridge piers and species that feed on them, but these impacts will be confined to the project area and further articulated in Phase II. Protective mitigation measures for aquatic life for Nightingale Pond will be developed when bridge designs are finalized and the full scope of impact to that area is determined. For example, aquatic basking turtles may occur on the shoreline or on coarse woody debris. At this time, the conceptual designs indicate there would be no impact to the pond because work would occur in the existing right-of-way. Protective measures such as silt fencing, coir log terracing, and runoff control, would be implemented during construction due to the close proximity of the roadway to the pond. Analysis of historical maps shows Nightingale Pond did not exist prior to the construction of the highway bridges. If during the design phase it is determined there would be any effects on the pond, USACE would analyze those impacts and conduct coordination and mitigation activities as necessary.

Birds and bats that commonly use the bridges would be disturbed by the process of constructing new bridges and demolishing the old ones. However, the noise from construction vehicles and equipment would likely deter animals from using the site during working hours, so significant impacts to wildlife populations are not expected. Any habitat that is converted to make way for the new bridges can be mitigated by either by returning the sites of the old bridges to natural conditions or restoring wooded habitats in nearby areas. Mitigation measures will be developed in detail in Phase II of the project when the full extent of impacts become clear. Through implementation of mitigation measures and BMPs, it is anticipated that Alternative and D would not have any adverse significant impacts, and overall impacts to wildlife are expected to be minor.

6.4.3 Fisheries and Marine Wildlife

The Canal is an important recreational fishery because of its swift currents and connectivity between Buzzards and Cape Cod bays. The Bournedale Herring Run entrance is located about one mile west of the Sagamore Bridge, and provides access for Alewife and Blueback Herring to spawn in Great Herring Pond. Other fish species that may be found in or near the Canal include: striped bass (*Morone saxatilis*), black sea bass (*Centropristis striata*), bluefish (*Pomatomus altatrix*), mackerel (*Scomber scrombrus*), bonito (*Sarda sarda*), tautog (*Tautoga onitis*), scup (*Stenotomus chrysops*), cod (*Gadus morhua*), summer flounder (*Paralichthys dentatus*), and winter flounder (*Pseduopleuronectes americanus*).

A March 1991 USACE survey of benthic habitat on the western edge of the Canal found no macrofauna, but did locate other sporadic marine ecological communities. These were dominated by polychaetes *Aricidea jefferysi*, *Amphitrite ornata*, and *Podarke obscura,* as well as the amphipod crustaceans *Ampelisca abdita* and *Corophium acutum.* Atlantic horseshoe crab

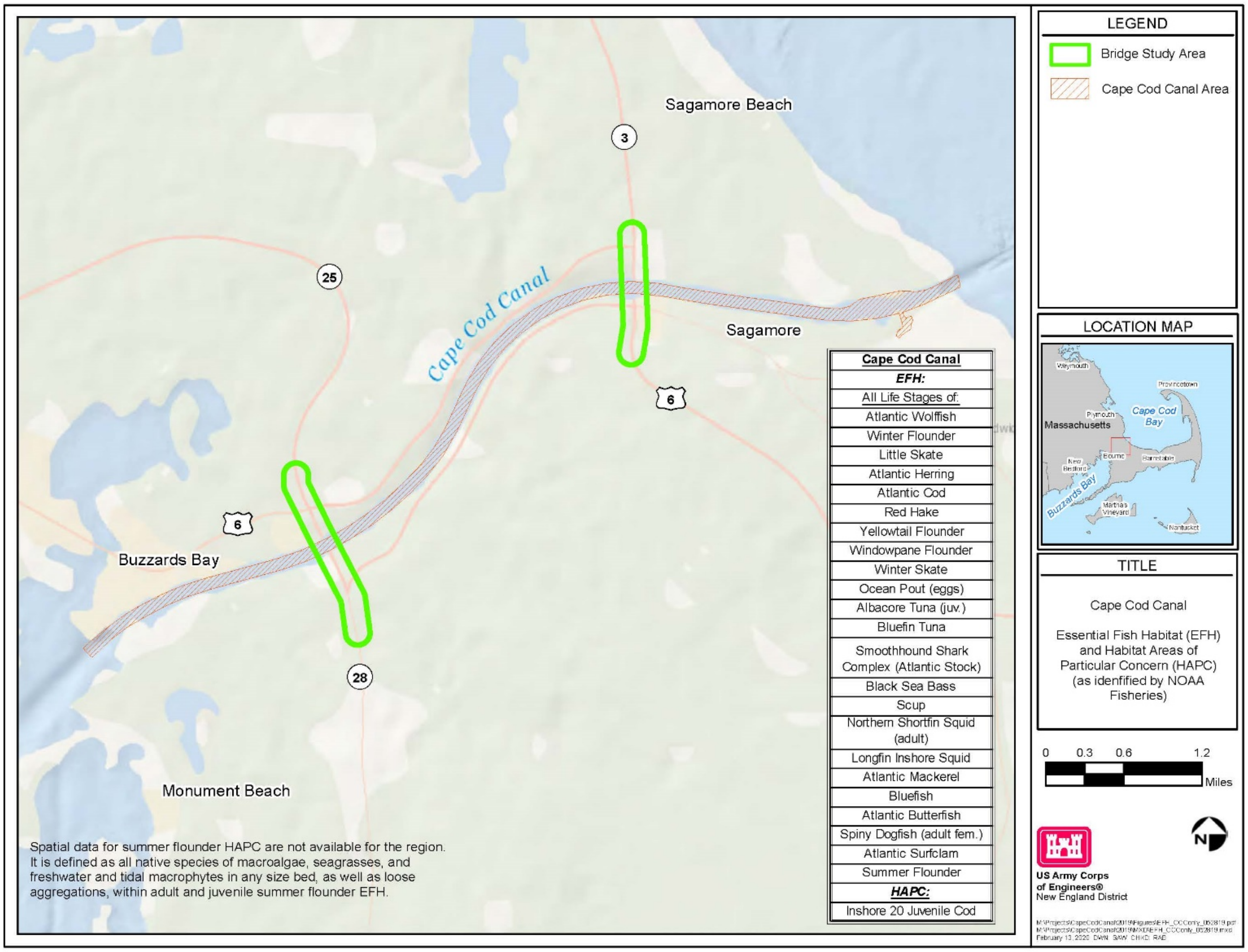
(*Limulus Polyphemus*) populates areas along the eastern seaboard, spawning on sandy beaches within bays and coves that are protected from wave action. There are recorded spawning sites within Buttermilk Bay, but none within the Canal. There is no eelgrass in the Canal's federal navigation channel, but it may be found outside of the channel near Hog's island on the western end of the Canal.

Essential Fish Habitat: The 1996 amendments to the Magnuson-Stevens Fishery Conservation Management Act (MSA) strengthen the ability of the National Marine Fisheries Service (NMFS) and the New England Fishery Management Council to protect and conserve the habitat of marine, estuarine, and anadromous finfish, mollusks, and crustaceans. This habitat is termed "Essential Fish Habitat," (EFH) and is broadly defined to include, "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity." The Cape Cod Canal falls into this category for multiple fish species, which are listed in EA Table 2. EA Figure 9 displays a map listing species with designated EFH in the Canal.

EA Table 2 - List of species that have designated EFH in the Cape Cod Canal

Species	Eggs	Larvae	Juveniles	Adults
Atlantic herring (*Clupea harengus)*			X	X
Atlantic cod (*Gadus morhua*)	X	X	X	X
American wolfish (*Anarhichus lupus*)	X	X	X	X
Little skate (*Leucoraja erinacea*)		X		X
Ocean pout (*Macrozoarces americanus*)	X			
Windowpane flounder (*Scophtalmus aquosus*)	X	X	X	X
Winter flounder (*Pseudopleuronectes americanus*)	X	X	X	X
Winter skate (*Leucoraja ocellata*)			X	X
Red Hake (*Urophycis chuss*)	X	X	X	X
Yellowtail flounder (*Limanda ferruginea*)			X	X
Albacore tuna (*Thunnus alalunga*)			X	
Bluefin tuna (*Thunnus thynnus*)				X
Smoothhound shark (*Mustelus spp.*)	X	X	X	X
Black sea bass (*Centropristis striata*)	X	X	X	X
Scup (*Stenotomus chrysops*)	X	X	X	X
Northern shortfin squid (*Illex illecebrosus*)				X
Longfin inshore squid (*Doryteuthis pealeii*)	X		X	X
Atlantic mackerel (*Scomber scombrus*)	X		X	X
Bluefish (*Pomatomus saltatrix*)			X	X
Atlantic butterfish (*Peprilus triacanthus*)	X	X	X	X
Spiny dogfish (*Squalus acanthias*)				X
Atlantic surfclam (*Spisula solidissima*)			X	X
Summer flounder (*Paralichthys dentatus*)		X	X	X

EA Figure 9 – EFH in the Cape Cod Canal



TITLE

Cape Cod Canal

Essential Fish Habitat (EFH) and Habitat Areas of Particular Concern (HAPC) (as idenfified by NOAA Fisheries)

Cape Cod Canal
EFH:
All Life Stages of:
Atlantic Wolffish
Winter Flounder
Little Skate
Atlantic Herring
Atlantic Cod
Red Hake
Yellowtail Flounder
Windowpane Flounder
Winter Skate
Ocean Pout (eggs)
Albacore Tuna (juv.)
Bluefin Tuna
Smoothhound Shark Complex (Atlantic Stock)
Black Sea Bass
Scup
Northern Shortfin Squid (adult)
Longfin Inshore Squid
Atlantic Mackerel
Bluefish
Atlantic Butterfish
Spiny Dogfish (adult fem.)
Atlantic Surfclam
Summer Flounder
HAPC:
Inshore 20 Juvenile Cod

Spatial data for summer flounder HAPC are not available for the region. It is defined as all native species of macroalgae, seagrasses, and freshwater and tidal macrophytes in any size bed, as well as loose aggregations, within adult and juvenile summer flounder EFH.

M:\Projects\CapeCodCanal\2019\Figures\EFH_CCConly_052819.pdf
M:\Projects\CapeCodCanal\2019\MXD\EFH_CCConly_052819.mxd
February 13, 2020 DWN: SAW CHKD: RAB

Environmental Consequences

Alternative A – No Action

The no action alternative would have no effects on EFH species because routine and emergency maintenance would not require in-water work.

Alternative B – Major Rehabilitation for Both Bridges

In-water work or elevated noise levels in the water due to major rehabilitation construction may have minimal temporary impacts on EFH species. A preliminary conference call was held with NMFS on May 20, 2019. NMFS also submitted a written response to the Draft EA December 20, 2019 stating the "Draft MRER EA accurately identifies the project elements that will be of highest concern for potential impacts to essential fish habitat (EFH)" (Appendix E). They requested the USACE wait until the design phase for further coordination and consultation pursuant to the MSA. The use of construction barges in the Canal to support major rehabilitation may be necessary. Such barges are equipped with spuds that are driven into the sediment to stabilize the vessel. Specific details on the barges, the length of time they would be utilized, and the size and depth of the spuds will be defined in Phase II when the specific construction needs for major rehabilitation are established. A construction supporting barge would not cause adverse shading on benthic communities due to the small size of this structure compared to the larger width and depth of the Canal. The exact size of the construction barge is unknown at this time and is dependent on specific project needs. The impact area associated with its spuds on prey resources and benthic habitat is also minimal, given the size and frequently dredged habitat of the Canal.

Alternative D (Preferred Alternative) – Replacement of Both Highway Bridges with New Bridges - 4 Lanes and 2 Auxiliary Lanes

Underwater work related to the removal of existing bridge piers may affect EFH or fish species. The USACE will ensure these resources are considered through consultation with NMFS at the design and construction phase of this project pursuant to the MSA. The USACE proposes to move the bridge piers from the water to the Canal shoreline, thus removing those structures as habitat.

Replacement would also require in-water barges to hold support cranes. The needed dimensions of these barges are unclear at this time and will be defined in Phase II during consultation with NMFS. Preliminary estimates indicate barge-supported cranes would be required for approximately 8 months (two months for construction and two months for demolition for each bridge). However, the small size of the project area will not substantially affect the highly mobile EFH species or their habitat, and the Canal is expected to remain a highly productive ecosystem because of the connectivity with Cape Cod and Buzzards Bay. A construction supporting barge would not cause adverse shading on benthic communities due to the small size of this structure compared to the larger width and depth of the Canal. The exact dimensions of construction barges are dependent on specific project requirements, which are not yet known and will be defined in Phase II. The impact area associated with its spuds on prey resources and benthic habitat is also minimal, given the size and frequently dredged habitat of the Canal. Potential noise impacts from the project on fisheries and marine wildlife will be evaluated in Phase II of the project in consultation with NMFS, using their Technical Guidance for Assessing the Impacts of Anthropogenic Sound on Marine Mammal Hearing (Version 2.0). If impacts to EFH occur, USACE will coordinate with NMFS to determine the mitigation requirements. These may include restoration of hard-bottomed or marine epifaunal habitat, either within the federal navigation project or at an agreed upon location within the Commonwealth of Massachusetts.

6.4.4 Threatened and Endangered Species

Federal Threatened and Endangered Species: The USACE conducted an initial screening of the proposed project site utilizing the US Fish and Wildlife Service (FWS) Information for Planning and Consultation (IPaC) webpage and as well as requesting an official species list from FWS (Appendix I). These records indicate that the federally-threatened northern long-eared bat (NLEB; *Myotis septentrionalis*), endangered northern (Plymouth) red-bellied cooter (*Pseudemys rubriventris*), endangered American chaffseed (*Schwalbea americana*), roseate tern (*Sterna dougalli dougallii*), piping plover (*Chadrius melodus*), and red knot (*Calidris canutus*) may occur in the project area. EA Figure 10 provides a map of federally-listed species and critical habitat occurring in or near the study area. Note that northern long eared bat may occur there but has a widespread distribution, American chaffseed is not found in the study area, and the birds are present in a transient or migratory nature.

During summer months, the NLEB roosts in decaying hardwood snags (Menzel et al, 2002) in trees with more than four inches diameter at breast height, and they may also roost in softwood species. Preferred roosts are clustered in stands of large trees (MADFW, 2015), and other roosting habitat includes man-made structures such as bridges, buildings, utility poles, and barns (USFWS, 2015). NLEB forage under the forest canopy in structurally complex habitats, often above small ponds, vernal pools, small streams, or along gravel paths or roads, and at forest edges. No winter hibernacula are documented in Barnstable County (MADFW, 2015). The primary threat to NLEB is White Nose Syndrome, a fungal disease responsible for much of the species' decline. A 2017 EA for a proposed solar photovoltaic installation near the Canal used an acoustic monitoring survey to document bat activity around the Sagamore Bridge and nearby Midway Recreation Area. This survey showed limited *Myotis* activity (1.5% of total bat activity) in the vicinity of the Sagamore Bridge, which included 0.7% little brown bat (*Myotis lucifugus*), 0.6% NLEB, and 0.1% eastern small-footed bat (*Myotis leibii*). The overwhelming majority of bat activity came from the big brown bat (*Eptesicus fuscus*) and eastern red bat (*Lasiurus borealis*), with a minor component of the hoary bat (*Lasiurus cinereus*). The bat species are expected to be similar at the Bourne Bridge, because of the similarity and proximity of the bridges and surrounding habitat of coastal mixed pine- hardwood forest and development.

The federally endangered northern (Plymouth) red-bellied cooter is a large freshwater basking turtle inhabiting deep coastal plain ponds. It only occurs in a small area of Plymouth County, MA, and is a disjunct population of the northern red-bellied cooter. It subsists on aquatic vegetation and requires good water quality and suitable basking, nesting, and overwintering sites free from disturbance. Although most of their time is spent in freshwater ponds, northern red-bellied cooters may also be found on land. In late spring and early summer, females select nesting sites in sandy soil usually within 100 yards of the pond. The turtles are typically active from late March to October. During the winter, they rest on the bottoms of ponds under the ice ina state of relative inactivity or hibernation (MA DFW, 2016). Critical habitat of the Massachusetts population of the Plymouth red-bellied cooter is located within Plymouth County.

The federally-endangered American chaffseed was recently re-discovered on Cape Cod for the first time since 1965. American chaffseed is a perennial herb standing one to two feet tall with large purplish-yellow flowers. This species requires partially open habitat with a frequent disturbance regime, and historically occurred in fire-dependent open pinelands and savannahs (USFWS, 2019). No American chaffseed plants occur in the project area, and there is no suitable habitat according to discussions with USFWS (USFWS and USACE, 2019a).

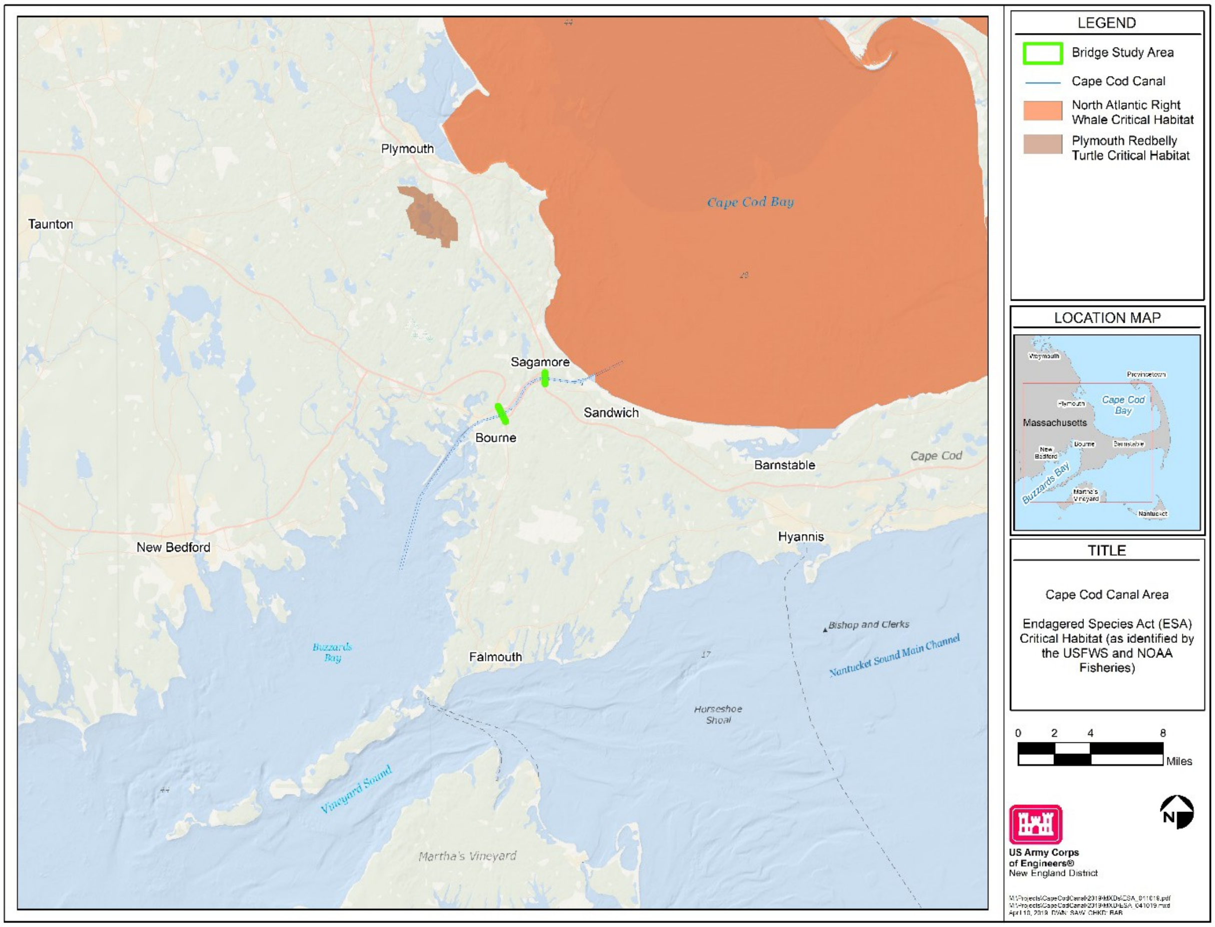
The federally-endangered roseate tern (*Sterna dougalli dougallii*) may occur in the project area. The roseate tern is an exclusively marine species of seabird. In North America, the roseate tern typically breeds on small islands in two distinct geographical areas from May to July (USFWS, 1998). The northeastern population breeds from North Carolina to Maine. After breeding, adult roseate terns and offspring feed in the northeastern Atlantic as late as August. Roseate terns usually begin to arrive in Massachusetts in late-April to mid-May to nest in a handful of coastal locations.

These locations are generally sandy, gravelly, or rocky islands and less commonly, at the ends of barrier beaches. The birds depart from breeding colonies in late-July and August and concentrate in staging areas around Cape Cod and the Islands, before departure for wintering grounds in September (MA DFW, 2016). Roseate terns may pass through the project area in a transient nature and may forage along the Canal shoreline. (USFWS and USACE, 2019b). However, there is no evidence that these birds use the Canal for roosting, nesting, or staging. A 2014 observation posted on eBird.org (2019) recorded ten roseate terns around the Bourne Bridge. Numerous other posts to this website documented sightings of roseate terns in the vicinity of the Canal but outside of the study area (eBird.org, 2019).

Other federally listed species include the piping plover (*Chadrius melodus*) and red knot (*Calidris canutus*). In a February 26, 2019, conference call, FWS stated that no habitat for these species exists within the project area, although they may migrate through. However, during migration they would be flying at higher altitudes and would not be affected by the project (USFWS and USACE, 2019b). The National Marine Fisheries Service (NMFS) has indicated seasonal movements of the endangered North Atlantic right whale (*Eubalaena glacialis*), the endangered Kemp's ridley turtle (*Lepidochelys kempi*), and the threatened loggerhead turtle (*Caretta caretta*) occur within Cape Cod Bay and as result, may be present in the project area at certain times of the year. Critical habitat for the right whale includes Cape Cod Bay, and the migratory routes of these species can include areas in Buzzards Bay as well. Other threatened and endangered whale and turtle species have also been observed in these areas, specifically humpback whales (*Megaptera novaeangliae*), finback whales (*Balaenoptera physalus*), sei whale, (*Balaenoptera borealis*), leatherback sea turtles (*Dermochelys coriacea*), and green sea turtles (*Chelonia mydas*). The threatened (Gulf of Maine Population)/endangered (New York Bight Population) Atlantic sturgeon (*Acipenser oxyrinchus*) may occur in the project areas with migrating and foraging habitat. The Cape Cod Canal Stranding Network, now part of the International Fund for Animal Welfare, has recorded a total of 44 (live and dead) marine mammal strandings in the Canal since 1998. The USACE also recorded the passage of a right whale through the Canal in April 2016.

In May 2019, the Canal was closed for several hours to all maritime traffic to allow for the passage of a pod of right whales, and in July 2019 a humpback whale was spotted transiting the Canal and safely escorted through by USACE personnel.

EA Figure 10 - Federally-listed species and critical habitat in the Cape Cod Canal



Environmental Consequences

Alternative A – No Action

The No Action alternative would have no effect on federally listed species because there would be no change in existing conditions for routine maintenance of the bridges.

Alternative B – Major Rehabilitation for Both Bridges and Alternative D (Preferred Alternative) – Replacement of Both Highway Bridges with New Bridges - 4 Lanes and 2 Auxiliary Lanes

The project would have no effect on federally listed species, except for NLEB which may roost under the bridges. The USACE will consult with USFWS pursuant to Section 7 of the Endangered Species Act (ESA) to determine if NLEB are present and identify measures necessary to minimize potential impact. The USACE will also consult with NMFS in Phase II of the project to protect federally listed marine species.

During a February 26, 2019 conference call, USFWS requested that the USACE initiate consultation when the project enters the design phase and the affected area is fully defined (USFWS and USACE, 2019a). Because the habitat use patterns of NLEB change over time, it would be more effective to conduct bat surveys closer to the time of actual activities. Mitigation measures will be identified during Phase II of the project in coordination with USFWS to avoid and minimize impacts. Potential mitigation measures may include first conducting a survey to determine bat presence/absence, then implementing best management practices or time of year restrictions on work in coordination with USFWS, or mitigation of bat habitat if impacts do occur.

The USFWS submitted a written response to the Draft EA and first phase of the project on December 23, 2019 and determined, "The proposed project, regardless of the final alternative selection and subsequent design, will largely occur within the footprint of existing developed land (i.e., the bridges and their supporting structures), and therefore is unlikely to have substantial impacts on wildlife or their habitat. However we encourage the Corps to consider listed and other high priority species during the planning and implementation of this project, and to pursue design elements that would minimize impacts and or provide beneficial impacts to these species or their habitats" (Appendix E).

It is unlikely that any northern red-bellied cooters would occur in the project area because of its proximity to the saltwater canal (USFWS and USACE, 2019b). It is confined to freshwater ponds in Plymouth County and eastern Bristol County, and none have been documented in the project area. Accordingly, there will be *no effect* on this species under any of the alternatives.

In a February 26, 2019, conference call, USFWS stated that no American chaffseed habitat exists in the project area and this species does not occur there. There will be *no effect* on this species. Roseate terns only pass through the project area on a transient basis. Because of their highly mobile nature and ability to evade disturbance, this project will have no effect on roseate terns under any of the alternatives. No piping plover or red knot habitat occur in the project area, but they may be present during migration. However, because they fly at higher altitudes during migration and do not use the bridges, there will be *no effect* on these species.

A preliminary conference call regarding ESA Section 7 consultation for marine species was held with NMFS on May 20, 2019. During this discussion, NMFS stated that no Atlantic or shortnose sturgeon have been documented in the Canal, but they may potentially occur there in the future in a rare and opportunistic manner. There are four species of sea turtles that are rare in the area of the Canal and may occur in October-December. Kemp's Ridley sea turtle and loggerhead sea turtle have been caught in Cape Cod Bay, and some beach strandings of sea turtles have been recorded. According to NMFS, their greatest concern among the ESA-listed species is the North Atlantic right whale. The timing of all bridge work will be designed to protect right whales that may transit the Canal. In order to avoid adverse effects to marine species during construction, the USACE will carefully monitor the Canal for the presence of protected species. If any marine mammals or sea turtles are identified during in-water construction activities in Alternatives B, C or D, all work will cease until the animal is safely out of the affected area. In May 2016 and May 2019, right whales were sighted transiting the Canal. The Canal was promptly closed to vessel traffic, and the whales were safely escorted through by USACE personnel. This practice would be implemented during this project if any right whales are sighted in the vicinity of the Canal.

Continuous monitoring of marine mammals and other protected species is already in place at the Canal, but would be conducted more intensively during work activities as an avoidance and minimization measure.

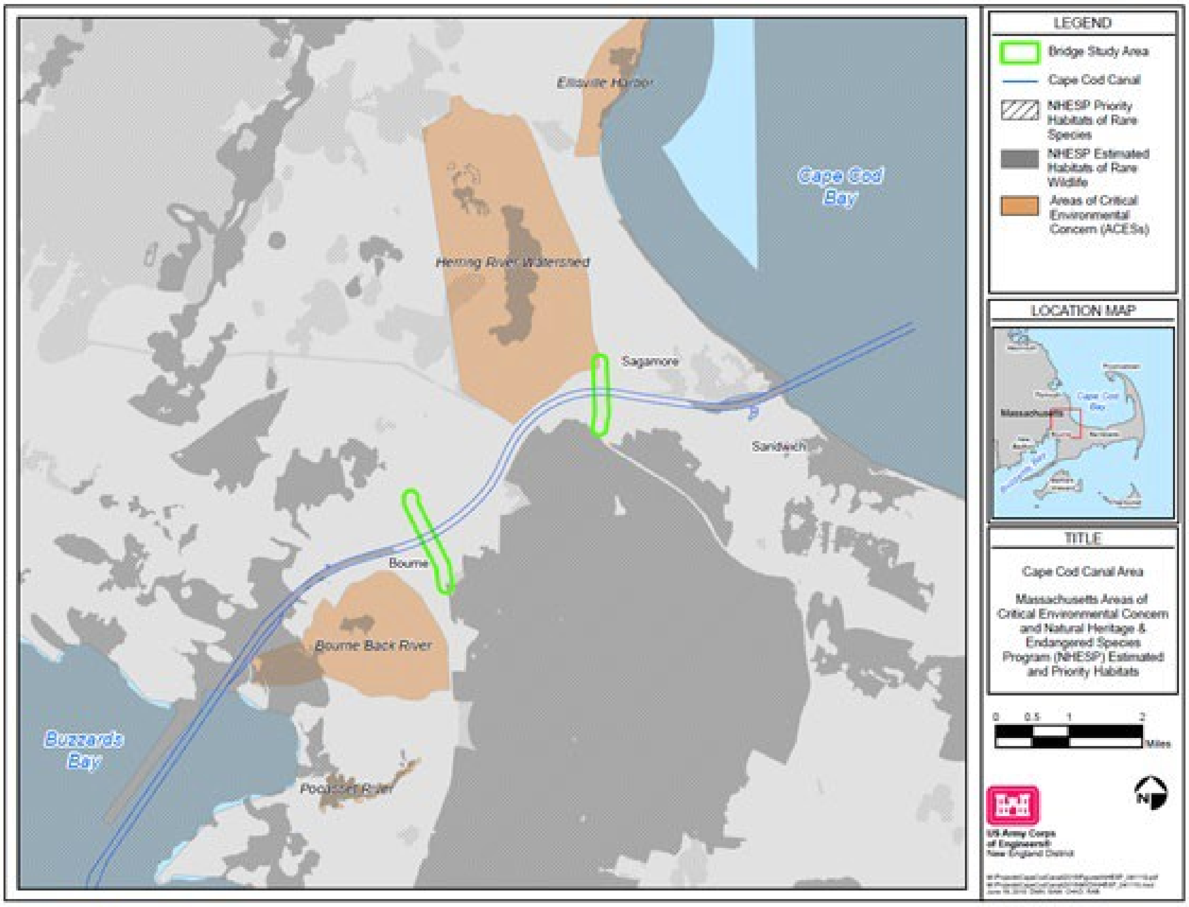
State Listed Threatened and Endangered Species: Forty-six species are listed by the Massachusetts Natural Heritage Endangered Species Program (MA NHESP) as occurring in Bourne, Massachusetts (MA NHESP 2019). According to the MassGIS, Estimated Habitats of Rare Wildlife and Priority Habitats of Rare Species are not mapped within either bridge site (2019). EA Figure 11 displays state-listed habitats and areas of critical environmental concern (ACECs) nearby the study area.

The Midway Recreation Area, a parcel adjacent to the Canal and owned by the USACE, is within NHESP Priority Habitat of Rare Species but will not be affected by the proposed project, (MA NHESP, 2019).

Coordination with the MA NHESP during the scoping process for the 2017 EA indicated that Eastern Box Turtles (*Terrapene carolina*), a Species of Concern, is known to inhabit the Midway site. Eastern Box Turtles are small, terrestrial turtles that range from southeastern Maine to northern Florida and as far west as Michigan, Illinois, and Tennessee. Although they occur in many towns in Massachusetts, they are more heavily concentrated in the southeastern section of the state. These turtles are found in many types of habitats including dry and moist woodlands, open fields, bogs, swales, stream banks, and well-drained bottomlands. The Eastern Box Turtle hibernates in the northern parts of its range from late October or November until mid-March or April depending on the weather. As soil temperatures drop, the turtles burrow a few inches under leaf litter or woody debris (MA NHESP, 2015).

Eastern Box Turtles are most active in the morning and evening, particularly after a rainfall, in the summer months. Mating is opportunistic and takes place anytime between April and October. Females nest in June or early July and may travel up to one mile to find appropriate nesting habitat which consists of early successional fields, meadows, utility rights of way, roadsides, woodland openings, residential lawns and gardens, beach dunes, and abandoned gravel pits. Habitat destruction resulting from development, road mortality, mowing of fields during the active season, and predation are some of the factors threatening Eastern Box Turtles (MA NHESP, 2015).

EA Figure 11 - MA NHESP Priority habitats of rare species and ACECs


Ellisville Harbor
Cape Cod Bay
Herring River Watershed
Sagamore
Sandwich
Bourne
Bourne Back River
Buzzards Bay
Pocasset River
LEGEND
Bridge Study Area
Cape Cod Canal
NHESP Priority Habitats of Rare Species
NHESP Estimated Habitats of Rare Wildlife
Areas of Critical Environmental Concern (ACESs)
LOCATION MAP
Massachusetts
Cape Cod Bay
TITLE
Cape Cod Canal Area
Massachusetts Areas of Critical Environmental Concern and Natural Heritage & Endangered Species Program (NHESP) Estimated and Priority Habitats
0
0.5
1
2
Miles
N
US Army Corps of Engineers® New England District

Environmental Consequences

Alternative A – No Action and Alternative B – Major Rehabilitation for Both Bridges

There will be no impacts to state-listed species because activities will not take place in areas designated as priority habitats of rare species or areas of critical environmental concern. Bridge maintenance or rehabilitation work will take place within the existing bridge footprints and rights of way.

Alternative D (Preferred Alternative) – Replacement of Both Highway Bridges with New Bridges - 4 Lanes and 2 Auxiliary Lanes)

There are no estimated habitats of rare wildlife or priority habitats of rare species within the study area, so no impacts to state-listed wildlife are expected. The boundary of the nearby Herring River ACEC crosses into the project area northwest of the Sagamore Bridge. However, this portion of the ACEC overlaps with existing roadways and approaches to the Sagamore Bridge in the northwestern section of the study area where the Rt. 6 on/off ramps are located. A replacement bridge would affect only a portion of the ACEC that is already currently occupied by the Sagamore Bridge approach and associated roadways, therefore no additional negative impacts will occur.

6.5 Historic and Archaeological Resources

The National Historic Preservation Act (NHPA) (1966) defines a historic property as any prehistoric or historic districts, sites, buildings structures, or objects that are eligible for, or listed on the National Register of Historic Places. Section 106 of the NHPA requires that a federal agency take into account the effects of an undertaking on historic properties.

The earliest pre-contact sites from the PaleoIndian Period (12,000 – 10,000 B.P.) have not been positively identified on Cape Cod. This can be partially explained by the loss of the early Holocene (post glacial) shoreline and associated sites due to rising sea levels. Many coastal sites dating to the early pre-contact period may be submerged or eroded by marine inundation and wave activity. Evidence of *in situ* Early Archaic Period (10,000 – 7,500 B.P.) sites are also relatively rare as the environmental landscapes continued to change and the sea levels continued to rise. Sites from the Middle Archaic Period (7,500 – 5,000 B.P.) to the Contact Period (1500 – 1650 A.D.) are much more apparent in the pre-contact record. This is no doubt due to the stabilization of erosion and inundation, as well as the recognition of particular landscapes as being archaeologically sensitive for certain sites.

Cape Cod was one of the first areas to be explored and settled by Europeans and as a result, contemporary accounts record Native American settlements as well as interactions with European traders, explorers and settlers. The importance of trade prompted the building of the Aptuxcet Trading Post in Bourne in 1627.

The first permanent European settlements in Sandwich, Cape Cod's oldest town, began around 1637. The early economy of Sandwich relied on the town's abundant natural resources such as alewives and herring, which were augmented by livestock and limited farming. Native Americans and colonists shared in the herring that came up the Herring River each year to spawn.

Sandwich was divided into two towns in April 1884. The town of Bourne was named in honor of Jonathan Bourne, a prominent Monument Village native.

After the completion of the first Canal bridges (1913), both Bourne and Sandwich improved their highways to accommodate the growing number of motorists crossing to Cape Cod. The improved transportation facilities brought increased tourism to both Bourne and Sandwich as more people came to Cape Cod. Buzzard's Bay Village became the main commercial center, while residential development continued in the beach front areas as well as along and north of Route 6. Sandwich and Bourne have continued to develop throughout the twentieth century as much of the Cape has, with a heavy reliance on tourism and vacationers in the summer months.

The Cape Cod Canal occupies an area that was originally traversed by the Monument, Herring, and Scusset rivers. The construction of the canal transformed these waterways and communities that surrounded them. Many of the commercial and residential buildings that were located near the Monument River were moved, as were two cemeteries.

The desire for a safe and quick passage between Buzzards Bay and Cape Cod Bay dates to the early 1600s. In his role as the Pilgrims' military leader, Myles Standish made many exploratory trips from Plymouth Colony to the area of the present day canal. After observing the Native Americans portage over the small isthmus between the Monument and Scusset rivers, Standish allegedly proposed that a canal be dug to form a protected waterway between the bays (Lovell 1984). Plymouth Colony did not have the funds or labor to undertake such a massive project, however, and nothing came of Standish's proposal.

Between 1892 and 1899, at least 30 different applications for canal charters were filed. Near the end of 1899, the Boston, Cape Cod and New York Canal Company won the charter. The main partner was DeWitt Clinton Flanagan. The company was allowed to raise $12 million through stock and bond sales to cover construction costs and given the right of eminent domain on property not previously purchased. Unlike earlier efforts, the charter provided more time to begin construction (Farson 1993: 25-27).

Flanagan approached August Belmont in 1904 with his canal plans. Belmont, a wealthy New York financier had built and financed the New York City subway in 1904 (Farson 1993: 29-31). In 1907, Belmont agreed to buy the rights and property of the Boston, Cape Cod and New York Canal Company. He paid $200,000 for the deposit to the state, $250,000 in bonds, and $1.4 million in stock. Belmont received the franchise, 1,080 acres of land along the route and the stock and bond options. Belmont's chief engineer was William Barclay Parsons, a noted railroad designer (Farson 1993: 31-33; Parkman 1978: 88; Reid 1961: 13-33).

The ceremonial groundbreaking took place on June 22, 1909 when August Belmont removed a shovelful of earth, proclaiming the start of the Cape Cod Canal. Two dredges began digging the approach channel in Buzzards Bay in August of the same year. The official canal opening was scheduled for July 29, 1914.

The foundation for a new moveable-span railroad bridge at Buzzards Bay was begun in November of 1909 and completed the following April. The bridge was completed by September 20, 1910, and then the railroad tracks were relocated.

Around the same time, construction began on two highway drawbridges to cross the canal at Bourne and Sagamore. The 729 foot long Bourne Highway Bridge was completed in May 1911. The Sagamore Highway Bridge was begun in April of 1912 and completed in February of 1913.

As U.S. involvement in World War I became increasingly more likely, the government became more interested in the military value of the canal (Farson, 1993: 55-56; Reid, 1961: 64-65). On July 25, 1918, the government took over the canal and turned over control to the Railroad Administration under the Secretary of War (Farson, 1993: 55-56). In 1928, the government took over permanent ownership of the bridge.

The government began a program of continuous maintenance of the canal. It was not until the National Industrial Recovery Act of June 1933 was passed that improvements could be made to the waterway. On September 6, 1933 the Public Works Administration authorized the construction of three bridges over the canal and widening of its land cut to 205 feet and allotted funding for the work. Construction began that December with the laying of the foundations for the two new highway bridges and the railroad bridge. The highway bridges were designed by the engineering firm of Fay Spofford and Thornkike of Boston, with architectural details by Cram and Ferguson of Boston. Both bridges were officially opened June 21, 1935 and are the two oldest continuous truss bridges in Massachusetts (Farson, 1993; Roper, 1990).

Work on the new Buzzards Bay Railroad Bridge, to replace the 1910 bridge, began on December 13, 1933. The noted engineering firm of Parsons, Klapp, Brinckerhoff and Douglas of New York City were responsible for the structural design of the bridge, which is a Waddell patent vertical lift bridge. John Alexander Low Waddell was the major designer of this type of bridge in the country (Hool and Kinne, 1943: 163). The bridge was officially completed on December 29, 1935 at a cost of $1.8 million (Parkman, 1978: 101; Reid, 1961: 108). When completed, this vertical lift span was the longest in the world.

The reconstruction of the canal was essentially complete by 1940.

The Bourne and Sagamore Bridges

The Bourne Bridge was completed in December of 1934. The builders were the American Bridge Company and the P.J. Carlin Construction Company. It is a three span, continuous "swinging" deck/through riveted steel truss bridge, with a Warren-type truss web. The bridge has highly stylized, "industrial Art Deco" light standards, which now have modern arms and heads.

The Sagamore Bridge was completed in 1935. It is of the same design as the Bourne Bridge, but is shorter. The bridge was published in 1943 (George A. Hool and W.S. Kinne, eds. in chief, *Movable and Long-Span Steel Bridges*, Second Edition, 1943 pp 255 c-d) as an example of continuous truss bridge design from the period 1923-1942.

The Bourne and Sagamore Bridges were determined individually eligible for the National Register of Historic Places (NR) under Criterion C for their graceful design and setting. They were also considered potentially eligible as part of a larger Cape Cod Canal historic district, although the boundaries and components of this possible district still need to be defined (Roper 1990). An historic inventory prepared by The Public Archaeology Laboratory Inc. for the USACE in 2000 defined features of a potential Cape Cod Canal historic district (Doherty, 2000).

In the project study area, there are three historic period resources, the Bourne and Sagamore bridges, and the canal. There are no known archaeological resources in the vicinity of the Sagamore Bridge. There are two archaeological sites within the vicinity of the Bourne Bridge, site 19 BN-224 pre-contact ceramics recovered in 1942, and post-contact archaeological site, BOU.1, the Gas House Site. The study area could have archaeological sensitivity. Many pre-contact and post-contact sites have been identified in the study area, and more are likely still unidentified. An intensive archaeological survey of the impact areas would identify the presence or absence of archaeological sites. A MassDOT report prepared by Stantec (2016) provides additional information.

Environmental Consequences

Alternative A – No Action

The no action alternative will have no effect on historic properties. The bridges would continue to be maintained and repaired and there would be no effect on local historic districts, individual buildings, or known and unknown archaeological sites, since there would be no change in appearance or location.

Alternative B – Major Rehabilitation Alternative

The rehabilitation of the Bourne and Sagamore bridges will have no adverse effect to the bridges and no effect on local historic districts, individual buildings or known and unknown archaeological sites. The SHPO concurred with this determination on August 22, 2019 (Appendix E). The major rehabilitation will include replacement of the bridge superstructure, deck replacement, including stringer replacement, abutment span replacement, exterior gusset plate retrofits, interior gusset plate repairs, miscellaneous concrete repairs, suspender cable replacement, paving, and painting. The bridges would continue in their current footprints, and while changes would be made to the bridges, they will look the same after rehabilitation as materials will be replaced in-kind. This condition is contingent on the use of previously disturbed laydown and staging areas. If new areas are chosen, an intensive archaeological survey may be required.

Alternative D- Preferred Alternative – Bridge Replacement – 4 Lanes and 2 Auxiliary Lanes

This alternative would have an adverse effect on the bridges and at least two identified archaeological sites, possible unidentified archaeological resources, and several historic districts. The effects would be indirect (visual and/or viewshed) as well as direct (possible archaeological sites). The tribes attended a meeting in March 2019 and concurred with this approach taken in Phase I of the study to evaluate continued repair and maintenance, major rehabilitation, or replacement of the bridges. A formal letter was also sent to the tribes on July 17, 2019. The SHPO concurred with this approach in a letter dated August 22, 2019 (Appendix E). Additional consultation with the SHPO and THPOs on the location of the bridges and the design would be required during Phase 2 of the project. A Memorandum of Agreement will be developed in consultation with the SHPO, THPOs, Massachusetts Board of Underwater Archaeological Resources (MBUAR), and local interested parties during this phase to develop a plan to avoid, minimize, or mitigate the effects of bridge replacement on historic properties. Consultation with the SHPO and tribes is ongoing.

6.6 Socioeconomics Resources

6.6.1 Demographics

Population size and composition: The current year-round populations of the Cape and Islands (Barnstable, Dukes and Nantucket Counties), and the town of Bourne are displayed in EA Table 3. The population of the Cape and Islands grew over 130% between 1970 and 2000 (Stats

Cape Cod 2015, Martha's Vineyard Commission 2006). Since 2000, population growth tapered in Dukes and Nantucket Counties, and slightly decreased in Barnstable County (EA Table 3). These population dynamics are largely attributed to a large influx of baby boomers retiring to the region, the subsequent increase in death rates due to an ageing population, and younger populations leaving the region to pursue employment and educational opportunities (Cape Cod Commission 2017, Renski et al., 2015).

EA Table 3 – Total Population

	Total population 2000 Census	Total population 2010 Census	Total population 2015 ACS
Bourne	18,721	19,754	19,729
Barnstable County	222,230	215,888	214,766
Dukes County	14,987	16,535	17,048
Nantucket County	9,520	10,172	10,556
Massachusetts	6,349,097	6,547,629	6,705,586

Source: 2010 United States Census, 2015 American Community Survey

Seasonal population: The populations of Cape Cod and the Islands experience dramatic seasonal shifts. The summer population of Cape Cod and the Islands is at least double the year-round population; and on a given summer day the population can be as many as five times the winter population[1] (Daley, 2015, Martha's Vineyard Commission, 2006). Many individuals have second homes on the Cape or Islands, and many are used as vacation rental properties during the summer season. Fifty percent of seasonal homes in Massachusetts are located in Barnstable County (Daley, 2015). The proportion of houses that are used for seasonal, recreational, or occasional use is at least eight times the state average across the three counties (EA Table 4).

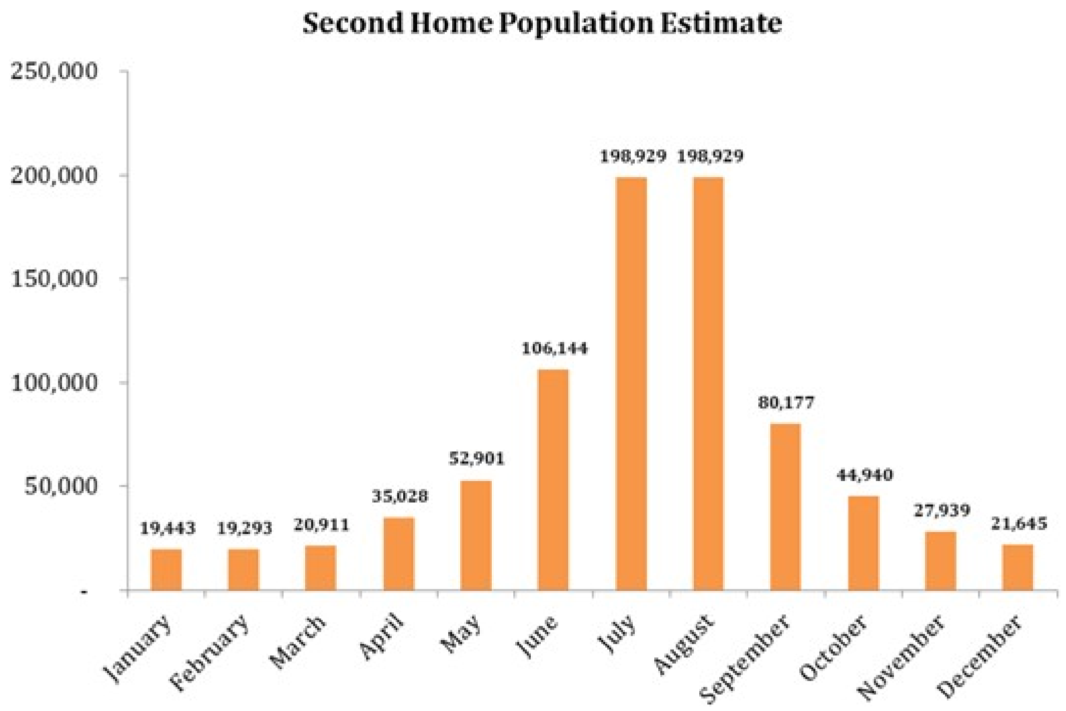
EA Table 4 – Proportion of seasonal-use houses

	Percentage of houses for seasonal, recreational, or occasional use
Bourne	20.6%
Barnstable County	35.5%
Dukes County	53.8%
Nantucket County	57.9%
Massachusetts	4.1%

Source: 2010 Census

The Cape Cod Commission estimated monthly populations in Barnstable County based on second home ownership, and show that the summer population can be ten times the winter population (EA Figure 12). Because these estimates of monthly population only consider visitors who own or rent a property, and does not take into account individuals doing day trips, they likely underestimate the actual population on a summer day.

EA Figure 12 - Second Home Population



From: Daley 2015.

Second home population estimates are based on UMass Donahue Institute's Second Home Owner Survey 2008 and the 2010 U.S. Census

Future population: Moody's analytics projects that economic growth in the area will stimulate in-migration resulting in an increase of 9,612 people to Barnstable County between 2015 and 2025; Crane Associates similarly projects a more conservative increase in population of 6,199 people (Crane Associates Team, 2017). Increases in the year-round population will consequently increase demands on local services and infrastructure, including the bridges.

---

[1] This estimate would include those visiting for the day – i.e. not spending the night on the Cape or Islands.

Age Distribution: The population increase between 1970 and 2000 was driven by people retiring to the Cape and Islands (Cape Cod Commission, 2017). As a result, the median age in Barnstable County is 30% higher than the state-wide median age (EA Table 5). Likewise, the percent of the population 65 and older is substantially higher, and the proportion of individuals 15 and under substantially lower, in Barnstable County compared with Massachusetts as a whole. These trends are expected to continue; the UMass Donahue Institute reports that by 2035, 35% of the Cape and Islands' population will be 65 or older (Renski et al., 2015).

EA Table 5 - Age and Ethnicity

	Median age	Percent 65 and older	Percent 15 and under	Percent foreignborn population	Percent white, non-hispanic
Bourne	46.25	21.2%	14.8%	3.8%	91.3%
Barnstable County	51.3	27.1%	14.1%	6.8%	91.1%
Dukes County	45.9	19.0%	16.6%	9.7%	92.1%
Nantucket County	39.5	13.4%	19.4%	16.3%	76.6%
Massachusetts	39.3	14.7%	18.3%	15.5%	74.3%

Racial Composition: With a population that is more than 90 percent Caucasian, the racial makeup of Barnstable is homogenous compared with the rest of the state (74.3% Caucasian) (EA Table 5).

Education: The proportion of Cape and Islands residents with a High School degree is slightly higher than the rest of Massachusetts. Barnstable County has a similar proportion of the population with a bachelor's degree compared with the rest of Massachusetts. The proportion of the population with a bachelor's degree is substantially lower in the town of Bourne compared with Barnstable County and Massachusetts as a whole.

EA Table 6 - Education, Employment and Income

	Percent with high school education	Percent with bachelor's degree	Labor force participation rate (age 16+)	Unemployment rate	Percent of households with retirement income	Median household income	Percent below poverty level
Bourne	96.6%	33.2%	62.2%	3.2%	23.0%	69,157	9.1%
Barnstable County	95.1%	40.1%	60.3%	4.2%	26.4%	63,251	8.7%
Dukes County	93.2%	40.3%	65.7%	3.4%	13.9%	64,222	11.7%
Nantucket County	94.8%	43.7%	74.8%	2.3%	12.2%	84,057	11.6%
Massachusetts	89.8%	40.5%	67.5%	5.1%	16.1%	68,563	11.6%

Source: 2015 American Community Survey

Environmental Consequences

Alternative A – No Action

There will be no immediate impact on current demographics in Cape Cod with routine maintenance of the bridges. In the absence of a major rehabilitation or replacement project, the bridges would deteriorate and require more frequent closures for repair, this will likely discourage migration onto Cape Cod and restrain population growth over time.

Alternative B – Major Rehabilitation for Both Bridges

Construction during the rehabilitation project could dissuade migration to Cape Cod and the Islands in the near term, thereby resulting in subdued population growth over that time. When the rehabilitation project is completed, conditions will resort back to those comparable to the current state. Therefore no lasting economic impacts are expected. Traffic congestion will continue to restrain any substantial population growth or changes.

Alternative D (Preferred Alternative) – Replacement of Both Highway Bridges with New Bridges - 4 Lanes and 2 Auxiliary Lanes

Construction of the replacement bridges is not expected to have a significant impact on population size or demographic makeup. Improved traffic and road conditions will likely attract more visitors and potentially new residents to Cape Cod. However, future development of land beyond the bridges will continue to limit population growth substantially (further detail in the Induced Development section below).

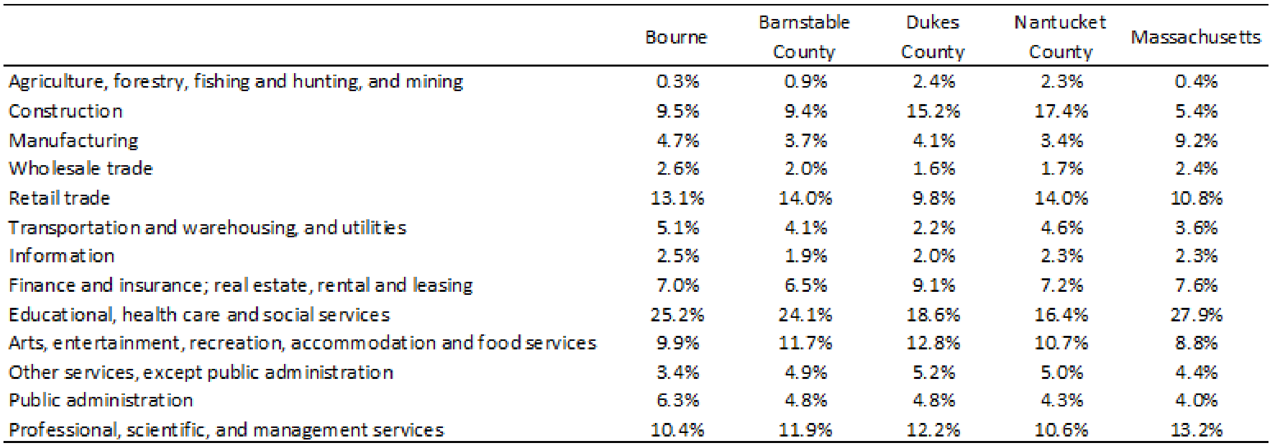
6.6.2 Community Economics

Employment and Industry: Barnstable County's labor participation rate is 7% lower than Massachusetts overall (EA Table 7), and the percent of households with retirement income in Barnstable county is more than 50% higher than Massachusetts overall. Barnstable County's lower labor force participation and greater proportion of households with retirement income is not surprising given many individuals relocate to Cape Cod in their retirement.

The unemployment rate in Barnstable County is below the state unemployment rate. Interestingly though, there are relatively fewer employment opportunities on the Cape and Islands compared with areas closer to the Boston metropolitan area. Therefore at least 13,000 Cape Cod residents commute over the Bourne and Sagamore Bridges daily to work on the mainland (MassDOT, 2016a). Median household income in Barnstable County is less than that of the state-wide median household income. Average weekly wage rates are also lower in Barnstable County ($833) compared with the state's average weekly wage rate ($1233) (Bureau of Labor Statistics, 2017).

In Barnstable County the five main employment sectors are: 1. Education, health and social services 2. Retail 3. Professional, scientific and management services 4. Arts, entertainment recreation, accommodation and food services 5. Construction. There is more employment in the construction, retail, and arts, entertainment recreation, accommodation and food services industries on the Cape and Islands compared with state-level industry employment rates. This is due to the seasonal economy typical of summer vacation destinations.

EA Table 7 - Proportion of Individuals Employed by Industry



	Bourne	Barnstable County	Dukes County	Nantucket County	Massachusetts
Agriculture, forestry, fishing and hunting, and mining	0.3%	0.9%	2.4%	2.3%	0.4%
Construction	9.5%	9.4%	15.2%	17.4%	5.4%
Manufacturing	4.7%	3.7%	4.1%	3.4%	9.2%
Wholesale trade	2.6%	2.0%	1.6%	1.7%	2.4%
Retail trade	13.1%	14.0%	9.8%	14.0%	10.8%
Transportation and warehousing, and utilities	5.1%	4.1%	2.2%	4.6%	3.6%
Information	2.5%	1.9%	2.0%	2.3%	2.3%
Finance and insurance; real estate, rental and leasing	7.0%	6.5%	9.1%	7.2%	7.6%
Educational, health care and social services	25.2%	24.1%	18.6%	16.4%	27.9%
Arts, entertainment, recreation, accommodation and food services	9.9%	11.7%	12.8%	10.7%	8.8%
Other services, except public administration	3.4%	4.9%	5.2%	5.0%	4.4%
Public administration	6.3%	4.8%	4.8%	4.3%	4.0%
Professional, scientific, and management services	10.4%	11.9%	12.2%	10.6%	13.2%

The Cape and Islands' economies rely heavily on summer tourism, and are thus seasonal. The number of employed individuals increases by nearly 20% during the summer months in Barnstable County. The economy is less seasonal today than it was several decades ago, but still depends heavily on summer tourism (Cape Cod Commission, 2017).

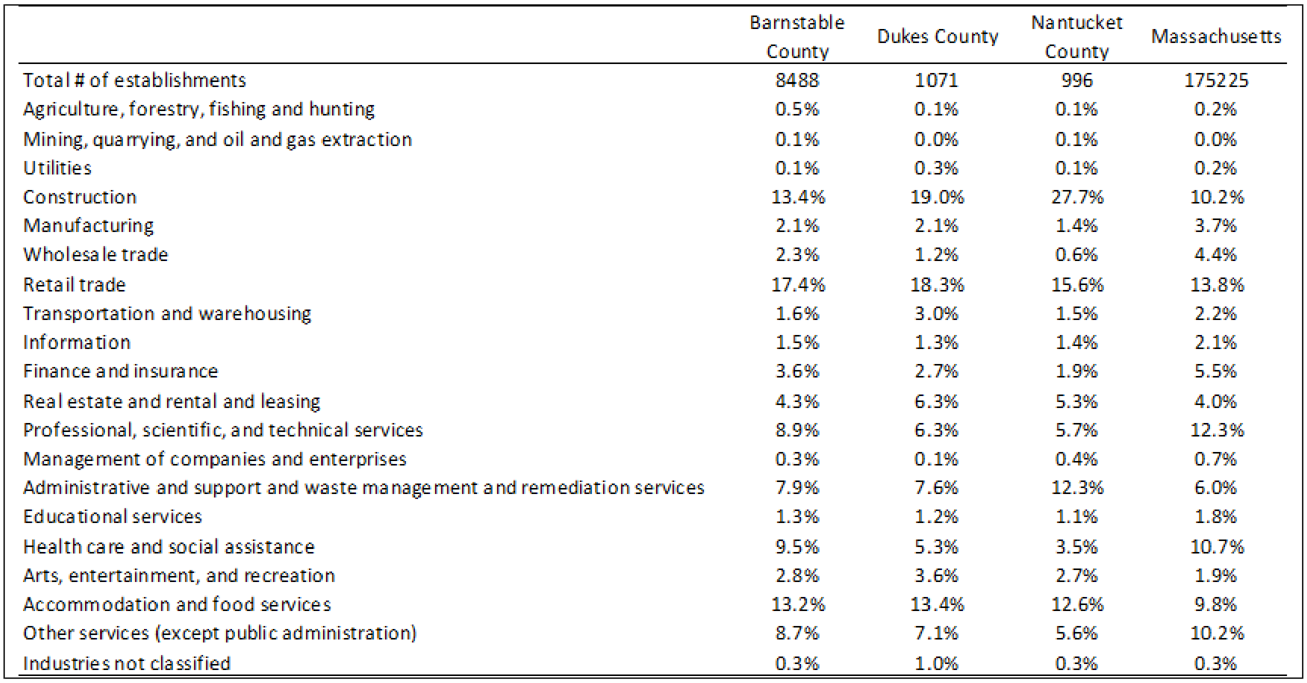
Cape Cod and the Islands have historically been home to a large number of small businesses, many of which serve the tourist industry. Respondents of the Cape Cod Business Climate Survey reported approximately one third of the total customer base to be seasonal visitors (UMass Donahue Institute, 2012). Sixty-two percent of establishments on the Cape employed between one and four people (90% employ less than 20), and over 70% of establishments on the Islands employed one to four people (EA Table 8). Typical of tourist areas, most businesses on the Cape and Islands are in the construction, retail and accommodation and food services industries (EA Table 9). Revenue generated in these sectors is substantial, and generally comprises a greater proportion of overall receipts compared with the state of Massachusetts as a whole (EA Table 10). More than half of businesses on the Cape are family owned (UMass Donahue Institute, 2012).

EA Table 8 - Proportion of small businesses

	Proportion of businesses with 1-4 employees
Barnstable County	**61.8%**
Dukes County	71.9%
Nantucket County	73.0%
Massachusetts	53.0%

Source: 2015 County Business Patterns, U.S. Census Bureau

EA Table 9 – Proportion of business in each industry



	Barnstable County	Dukes County	Nantucket County	Massachusetts
Total # of establishments	8488	1071	996	175225
Agriculture, forestry, fishing and hunting	0.5%	0.1%	0.1%	0.2%
Mining, quarrying, and oil and gas extraction	0.1%	0.0%	0.1%	0.0%
Utilities	0.1%	0.3%	0.1%	0.2%
Construction	13.4%	19.0%	27.7%	10.2%
Manufacturing	2.1%	2.1%	1.4%	3.7%
Wholesale trade	2.3%	1.2%	0.6%	4.4%
Retail trade	17.4%	18.3%	15.6%	13.8%
Transportation and warehousing	1.6%	3.0%	1.5%	2.2%
Information	1.5%	1.3%	1.4%	2.1%
Finance and insurance	3.6%	2.7%	1.9%	5.5%
Real estate and rental and leasing	4.3%	6.3%	5.3%	4.0%
Professional, scientific, and technical services	8.9%	6.3%	5.7%	12.3%
Management of companies and enterprises	0.3%	0.1%	0.4%	0.7%
Administrative and support and waste management and remediation services	7.9%	7.6%	12.3%	6.0%
Educational services	1.3%	1.2%	1.1%	1.8%
Health care and social assistance	9.5%	5.3%	3.5%	10.7%
Arts, entertainment, and recreation	2.8%	3.6%	2.7%	1.9%
Accommodation and food services	13.2%	13.4%	12.6%	9.8%
Other services (except public administration)	8.7%	7.1%	5.6%	10.2%
Industries not classified	0.3%	1.0%	0.3%	0.3%

Source: 2015 County Business Patterns, U.S. Census Bureau

EA Table 10 - Total sales, shipments, receipts, revenue and business done by establishments

	Barnstable Receipts ($1,000)	Dukes Receipts ($1,000)	Nantucket Receipts ($1,000)	Massachusetts Receipts ($1,000)
Mining, quarrying, and oil and gas extraction				4714
Utilities	1049	400	D	29525
Construction				3882960
Manufacturing	11948	1825	2263	321880
Wholesale trade	N	N	N	706935
Retail trade	77073	8817	8610	1683816
Transportation and warehousing(104)	23138	2174	2829	814293
Information	9909	1891	D	275497
Finance and insurance	32780	3315	1650	1243355
Real estate and rental and leasing	238824	30790	39172	5529594
Professional, scientific, and technical services	174984	21719	13435	4800603
Administrative and support and waste management and remediation services	62126	14579	9107	939990
Educational services	12930	1092	918	307925
Health care and social assistance	61591	6578	3664	1603643
Arts, entertainment, and recreation	34518	10849	9423	757688
Accommodation and food services	19409	3694	1356	258659
Other services (except public administration)	78909	11153	7081	1667474
Total of all receipts where sector data is available in all counties	828230	116585	99508	19928920
Retail percentage of total receipts	9.31%	7.56%	8.65%	8.45%
Arts, entertainment and recreation percentage of total receipts	4.17%	9.31%	9.47%	3.80%
Accommodation and food services percentage of total receipts	2.34%	3.17%	1.36%	1.30%

Source: U.S. Census Bureau, Economic Census, 2012.

Housing and Cost of Living: Median housing prices in Bourne are similar to that of the state median and are slightly higher than the state median across Barnstable County (EA Table 11). Median rent is slightly less in Bourne than the state-wide median rent. Barnstable County's median rent is the same as the state's;

EA Table 11 – Median housing values and rent

	2015 Median Housing Value	2015 Median Rent
Bourne	**334,600**	**988**
Barnstable	**363,500**	**1,104**
Dukes	660,800	1,428
Nantucket	902,500	1,609
Massachusetts	333,100	1,102

Source: ACS: 2011-2015 ACS estimates

Town-level cost of living indices are available via Sperling's Best Places Website. EA Table 12 compares the cost of living in Bourne with two adjacent communities on the mainland, Plymouth and Wareham. The overall cost of living index for Bourne is higher than Plymouth and

Wareham. The relative cost of living measures for the categories of expenditures suggests that it is primarily housing costs that drive the higher cost of living in Bourne. The median housing value for Plymouth and Wareham (323,000 and 254,100 respectively) is indeed lower than that of Bourne (2015 ACS).

EA Table 12 - Cost of living indices for Bourne, Plymouth and Wareham

	Bourne	Plymouth	Wareham
Overall	142.5	137.3	125.3
Food	113	120	120
Housing	193.1	169.2	131.7
Utilities	127.7	147.6	147.6
Transportation	107.6	105.7	105.7
Health	118.8	123.1	123.1
Miscellaneous	127.9	129.4	129.4

†100=national average
Source: http://www.bestplaces.net/cost-of-living/bourne-ma/sandwich-ma/50000

Environmental Consequences

Alternative A – No Action

There is no impact in the near term under the no action alternative. However, as the bridges continue to deteriorate, repair projects that create significant traffic closures and delays will be necessary to keep the bridges in functioning condition. Given the large number of workers commuting on and off the Cape via the bridges daily, there could be an impact on employment potential and wages for those living on Cape Cod. This in turn could have a dampening effect on tourism, local business, and housing values on the Cape.

Alternative B – Major Rehabilitation for Both Bridges

Given that at least 13,000 Cape Cod residents commute over the Bourne and Sagamore Bridges daily to work on the mainland, construction during the rehabilitation project will create traffic congestion which will likely impact wages and job potential for Cape Cod residents that require commuting on and off the Cape via the bridges daily. In addition, the abundance of small businesses that heavily rely on tourism will be negatively impacted when tourists are deterred from traveling to the Cape given increased traffic congestion. This will dampen the overall economy of Cape Cod and in turn could lower demand for homes on Cape Cod and the Islands, lowering home prices in the near term. This will occur each time the bridges require major rehabilitation which is expected to occur twice in the next fifty years. Between rehabilitations, conditions will become comparable to current conditions.

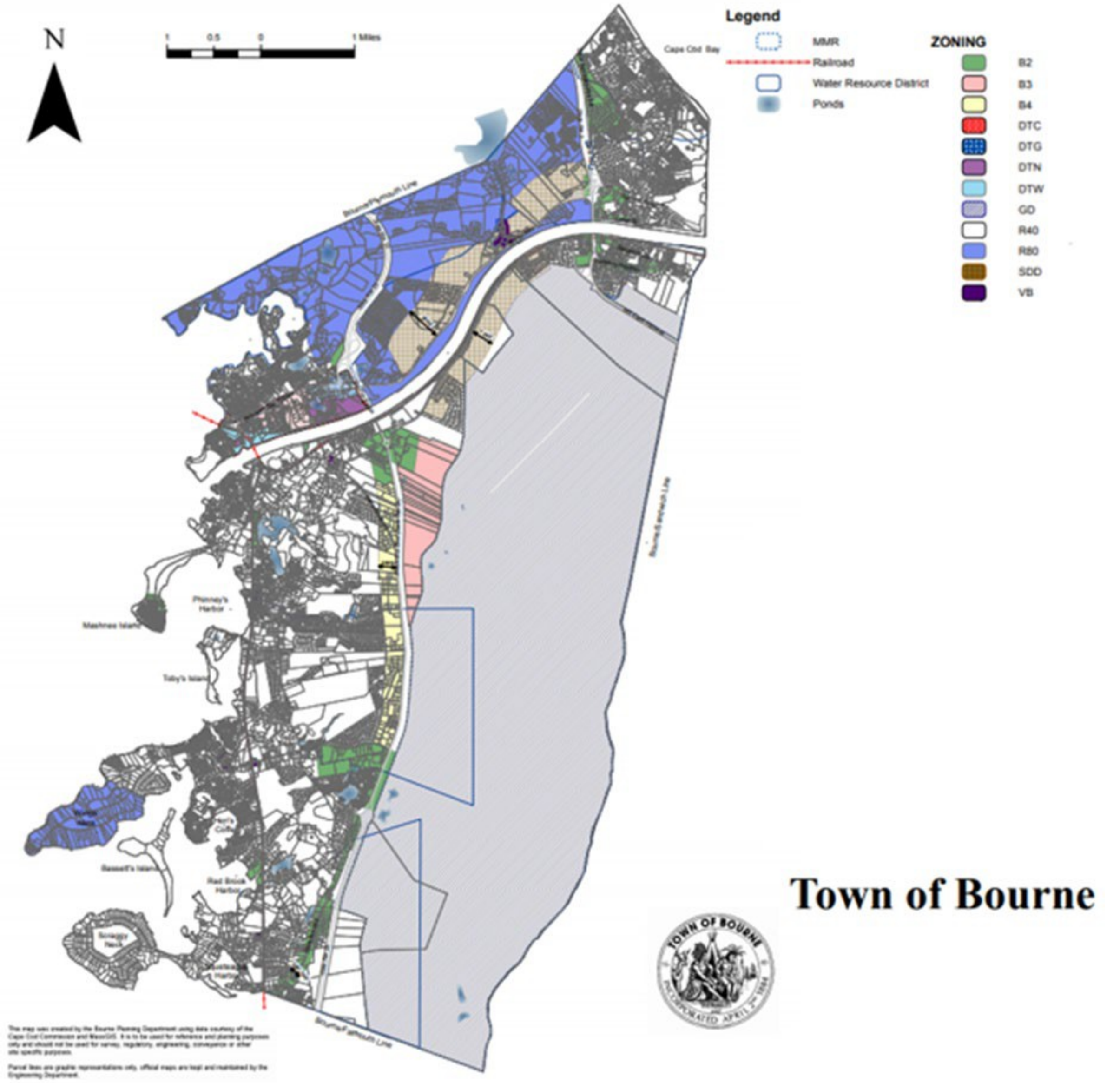
Alternative D (Preferred Alternative) – Replacement of Both Highway Bridges with New Bridges - 4 Lanes and 2 Auxiliary Lanes

Safer, more efficient bridges would ease traffic congestion especially in Alternative D. The ease of traffic could improve commute times for those 13,000 residents commuting off Cape Cod daily. It could also make traveling on and off the Cape more attractive to potential labor force participants. Safer and more efficient bridges may also attract more tourism onto Cape Cod and the islands increasing seasonal demand for local goods and services. Overall this will positively benefit the economy and could drive up demand and prices in the housing market.

6.6.3 Land Use and Zoning

Bourne Land Use: *Zoning:* The focus area of this study consists of a 500 foot buffer zone around the existing Bourne and Sagamore Bridges (EA Figure 2). This is the location where all potential projects will be constructed including the replacement bridges which are expected to be built adjacent to the existing bridges. The focus area will be more clearly defined in Phase II of the project. The focus area is contained almost entirely within the town of Bourne. The downtown area is zoned for a variety of uses, including higher-density public works, landscaping, construction, and retail facilities. Moving toward the east, the "village" area is zoned to preserve the historic character of the town, which features compact buildings with traditional Cape Cod architecture. Other parts of the downtown area are zoned for natural resource protection. Much of the area abutting the Bourne Bridge is zoned for residential use or protected forest.

EA Figure 13 – Bourne Zoning Map



B2 (Business): To accommodate general business development in areas serviced by major traffic arteries, and where conflict with residential development will not be substantial
B3 (Business): To reserve areas for business development without single-family residential development, in areas of 10 acres or more well suited by utilities, access, topography, and surrounding for such use
B4 (Business): To provide for business development along arterial routes with careful control over environmental and traffic impacts
DTC: Downtown Core
DTG: Downtown Gateway
DTN: Downtown Neighborhood
DTW: Downtown Waterfront
GD (Government District): To provide for necessary governmental functions on publicly owned land
R40 (Residential): Residential with minimum of 40,000 sf per lot
R80 (Residential): Residential with minimum of 80,000 sf per lot
SDD (Scenic Development District): To gain intensive use of land, while at the same time preserving or enhancing highway views of the canal, ocean, or bay, preserving or enhancing landscaping and tree cover, minimizing visibility of parked autos and the intrusion of commercial signs, and avoiding creation of hazards or congestion. Each SDD created on the Zoning Map shall be not smaller than 40 acres in extent, shall be accessible directly via state-owned highway, and shall be so located that ocean or canal visibility exists or can reasonably be expected to be gained
VB (Village Business): To provide for village-oriented business compatible with small scale environs and nearby residences

Source: Town of Bourne, Unofficial Zoning Map

Environmental Consequences

Alternative A – No Action and Alternative B – Major Rehabilitation for Both Bridges
There will be no impacts to land use or zoning under Alternatives A and B as the existing footprint of the bridges will not change.

Alternative D (Preferred Alternative) – Replacement of Both Highway Bridges with New Bridges - 4 Lanes and 2 Auxiliary Lanes
There are no known conflicts with federal, state, and local land use plans in the area directly associated with the proposed replacement bridges footprints. There are no future land plans by local Native American Tribes however the area is considered sensitive for tribal resources. MassDOT proposed road construction projects surrounding the bridges are more likely to be undertaken, changing some land usage. The proposed footprints of the new bridges are located on federal public lands/waterways, residential properties, and some commercial property. Therefore the land use of those specific properties will be redesigned for bridge construction. The projects do not conflict with proposed federal, regional, state, and local land use. Indirect effects are discussed in further detail in Section 7.

6.6.4 Recreation

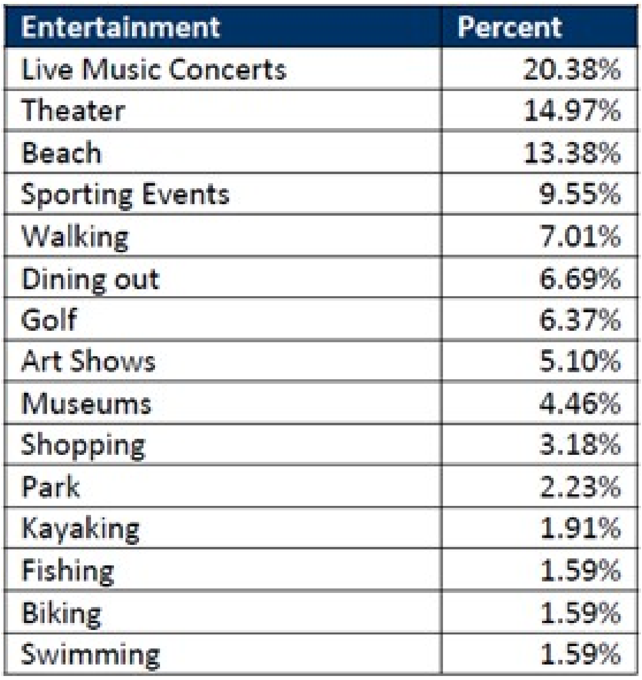
Leisure time and recreational opportunities influence individuals' well-being. Project activities and outcomes that influence the availability or accessibility of leisure time and recreational opportunities thus need to be considered.

Being a major tourist destination, recreational activities abound on the Cape and Islands. The area hosts some of the country's finest beaches, walking and biking trails including Cape Cod National Seashore, which had 4,722,344 visitors in 2016 (http://www.whycapecod.org/tourism-statistics.html). Shopping, water sports, fishing, boating and golf are major leisure activities, as are dining out and live entertainment. Retail; arts, entertainment and recreation; and accommodation and food services are among the most important industries in Barnstable, Dukes and Nantucket Counties (EA Table 7 and EA Table 8). These industries play a more important role in local economies than they do across the state of Massachusetts as a whole.

Recreational opportunities on the Cape and Islands are valuable to the local economy because they draw tourists to the area. Local residents also enjoy the abundant recreational opportunities available on the Cape and Islands. Many residents move to the Cape and Islands so that they can enjoy the cultural and recreation amenities that exist there. More than 60% of Cape Cod residents surveyed in 2013 reported the primary reason they live on the Cape is because it is a "great place to spend time" (The Chesapeake Group, 2013). The 2008 Second Homeowner's survey concluded that residents relocating permanently to their Cape summer homes plan to increase their use of cultural attractions and activities, particularly theatre and music venues (UMass

Donahue Institute, 2008). Concerts, theatre and beach activity are the most common forms of recreation that residents report participating in (EA Table 13).

EA Table 13 – Cape Cod resident recreational participation



Entertainment	Percent
Live Music Concerts	20.38%
Theater	14.97%
Beach	13.38%
Sporting Events	9.55%
Walking	7.01%
Dining out	6.69%
Golf	6.37%
Art Shows	5.10%
Museums	4.46%
Shopping	3.18%
Park	2.23%
Kayaking	1.91%
Fishing	1.59%
Biking	1.59%
Swimming	1.59%

(The Chesapeake Group, 2013)

The Cape Cod Canal itself is also a prime destination for biking and walking with over 14 miles of paved and off-road trails.

The USACE is responsible for operating and maintaining the Cape Cod Canal. The primary mission of the Canal is to provide safe navigation to the commercial and recreational vessels that transit the 17.5 mile waterway each year. However the 1,000 acres of land that surrounds the canal provides diverse recreational opportunities such as hiking, fishing, biking, picnicking, and ship watching. The USACE operates the Cape Cod Canal Visitor Center and multiple recreation areas equipped with restrooms, picnic areas, and parking lots. Service roads which parallel both sides of the Canal are available for bicycling, jogging, and walking. (https://www.nae.usace.army.mil/missions/recreation/cape-cod-canal/)

Environmental Consequences

Alternative A – No Action

With ongoing bridge maintenance, Cape Cod residents and tourists would continue to experience intermittent traffic congestion leading to longer travel times to their recreation destination, and therefore, reduced time available to enjoy their recreational pursuits. This could reduce revenues to businesses that rely on the public's enjoyment of recreational activities. The frequency of intermittent repairs would increase as the bridges age, exacerbating these effects over time. Residents' and tourists' access to boating, fishing, trail, or other recreational activities may be temporarily affected by construction activity if construction renders some areas inaccessible to the public, for example some areas of the service roads may be temporarily restricted and even access through the canal in the instance of emergency canal repair projects.

Alternative B – Major Rehabilitation for Both Bridges

Each major rehabilitation project is expected to occur over three years non-concurrently. A second rehabilitation project for each bridge will also occur 40 years subsequently. These projects require extensive closures of lanes and bridges during construction. In addition, as the bridges age and conditions start to deteriorate, the bridges will require additional safety maintenance measures. Therefore there will be major disruptions to traffic for residents and tourists. The disruptions will limit demand and time able to be spent at recreational activities. This will be harmful to the local economies that rely on tourism. In addition, residents' and tourists' access to boating, fishing, trails, or other recreational activities may be affected by rehabilitation activity if construction renders some areas inaccessible to the public particularly in the areas directly surrounding the canal during the rehabilitation projects. For example, during rehabilitation, there will likely be temporary restrictions to service roads or access through the canal. Therefore, under Alternative B there would be temporary short-term impacts to recreation.

Alternative D (Preferred Alternative) – Replacement of Both Highway Bridges with New Bridges - 4 Lanes and 2 Auxiliary Lanes

Impacts to traffic will be limited as the new bridges will be built adjacent to the current bridges and therefore do not require significant lane and bridge closures during construction. In addition, the replacement bridges will require less frequent maintenance work (and therefore closures). Construction of the bridges will however require the closure of the canal for 30 days each which will disrupt fishing and boating activities. In addition, there may be other temporary impacts such as portions of the access road will be closed for public use during construction which is projected to last for five years for each bridge. Therefore, there would be no significant impacts to recreation under Alternative D.

6.6.5 Public Utilities

Gas, electric, and telecommunication/fiber companies have been given permission by the USACE to place utilities across the Canal on the Sagamore and Bourne bridges. Companies directly locating utilities on the bridges or in the area of the bridge footprint include Comcast, Verizon, Open Cape, National Grid, Eversource/NSTAR, and Algonquin Gas. These connections provide critical utility connection to the entirety of Cape Cod.

EA Table 14 – Utility Licenses

Company	**Utility**	**Description**
Comcast	Telecommunications	Cables on both bridges
Verizon	Telecommunications	Cables on both bridges
National Grid	Gas	Sagamore Bridge
National Grid	Gas	Bourne Bridge
Formerly Colonial Gas	Electricity	Electric transmission wires under Sagamore Bridge
Open Cape	Telecommunications	Innerduct for fiber optic cable on Sagamore Bridge. Sub-license from Verizon
NSTAR	Electricity	Electric wire, poles near Bourne Bridge
Algonquin Gas	Gas	Gas line near Sagamore Bridge

Environmental Consequences

Alternative A – No Action

In the no-action alternative, the utility companies would continue to operate utilities on the bridges through licenses or easements with the USACE; therefore, there would be no impacts to utilities under this alternative.

Alternative B – Major Rehabilitation for Both Bridges

Major rehabilitation is too hazardous to accomplish with live gas and electric lines, long interruptions would also not be practical for the telecommunications and other utilities. Therefore, in the instance of major rehabilitation, relocation of the wires, gas lines, and pipelines would be accomplished with a form of conduit buried under the canal, which would need to be approved and constructed prior to removing utilities from the bridges to limit any disruption to services. The underground relocation would be accomplished using horizontal directional drilling (HDD) technology The HDD process generally involves boring a pilot hole into the ground beneath a water body, and then enlarging the hole with one or more passes of a reamer until the hole is the necessary diameter to install the pipeline. The prefabricated pipe segments are then pulled through the hole to complete the crossing. Staging areas are established along both sides of the proposed crossing typically at the entry and exit points (Algonquin/Spectra Energy Partners, 2014).

The site-specific HDD procedures used to relocate the gas lines under the Canal will not be determined until Phase II of the project,

Alternative D (Preferred Alternative) – Replacement of Both Highway Bridges with New Bridges - 4 Lanes and 2 Auxiliary Lanes

If the bridges were to be replaced, the utilities would have to be placed under the newly constructed bridges. Some utilities, including natural gas lines, would need to be relocated off the bridges due to safety considerations. It is anticipated that National Grid would install new 10-inch pipes inside conduits below the Canal at both bridge locations using HDD. The specific location and HDD methodology used to relocate these lines will be determined and analyzed during the design phase of the project (Phase II). Relocation of the utilities will incur additional costs at the burden of the grantee. Placement of new lines/pipes will occur prior to removing the existing bridges and precautions will be taken to limit disruption of services.

The HDD process uses bentonite-based drilling fluids. The drilling fluids are tested for specific engineering properties to ensure a successful HDD installation. The environmental impact associated with HDD is the potential for inadvertent release of drilling fluids to the surface along the drill alignment during drilling operations. The drilling fluids are typically a mixture of fresh water and bentonite. Bentonite is natural clay usually mined in Wyoming. Bentonite is extremely hydrophilic and can absorb up to ten times its weight in water. Typically, the drilling fluid contains no more than 5 percent bentonite (95 percent fresh water).

The potential drilling under the canal will not affect the sole source aquifer. It is anticipated that HDD will take place approximately 30 ft. below the canal, although exact depths of the drill route cannot be estimated during Phase I without more specific drilling plans. The bedrock surface altitude ranges from 50 feet below National Geodetic Vertical Datum (NGVD) 1929 near the Canal, to 500 ft. below NGVD 1929 near the Monomoy lens. While the HDD would contact the water table, based on USGS water table surface contour maps, the aquifer is much deeper and is not likely to be impacted by horizontal drilling. (Walter et al 2016). However, further analysis in Phase II would be conducted when the exact HDD entry location, drill routes, drill angles, and exit points have been identified.

Potential impact to the water table exists if drilling fluids, composed of a slurry of bentonite clay and water, were inadvertently released into the environment during the drilling process. According to Algonquin Gas, drilling fluids typically contain no more than 5 percent bentonite (95 percent fresh water). Best management practices (BMPs) and site-specific clean-up measures will be developed prior to any drilling commencing and implemented throughout the HDD process. According to Algonquin BMP procedures (2014), if a release of drilling fluids does occur, containment is typically achieved by excavating a small sump pit (5 cubic yards) at the site of the release, surrounding the release with hay bales, silt fence and/or sand bags. Once contained, the drilling fluid is either collected by vacuum trucks or pumped back to the mud recycle unit, or to a location where vacuum trucks can be accessed. The fluids are then transported either back to the HDD Drilling Rig or to a disposal site".

(Spectra Energy Partners, 2014). Therefore there would be no adverse impact to the environment.

Public Water Supply

The North Sagamore Water District is a community public water supplier located in Bourne, which supplies drinking water and fire protection to 4,600 residents and businesses in the Sagamore Beach Village on the mainland side of the Sagamore Bridge. The District's two largest producing wells and a large storage tank are located on the west side of the Sagamore Bridge approach, while the majority of District customers reside on the east side.

There are two major transmission water mains and numerous arterial mains located in the Sagamore Bridge Study Area. A twelve inch transmission water main runs alongside and under the existing Sagamore Bridge and is located on an easement granted to the Water District by USACE (Easement no. DACW33-2-79-129 Cape Cod Canal). A second transmission main runs along Scenic Highway under the Route 3 overpass/approach to the Sagamore Bridge.

Environmental Consequences

Alternative A – No Action and Alternative B – Major Rehabilitation for Both Bridges

In the no-action alternative, transmission water mains and the water system would continue to operate without any interruption. Therefore, there would be no impacts to the public water supply under this alternative.

Alternative D (Preferred Alternative) – Replacement of Both Highway Bridges with New Bridges - 4 Lanes and 2 Auxiliary Lanes

If the bridges were to be replaced, the water transmission lines would need to be relocated. The transmission water mains are integral to the operation of the water system and cannot be offline for any period of time. The Corps will coordinate with the N. Sagamore Water District during Phase II of the project to ensure there will be no interruption to water supply to area residents. Therefore there is no impact to the public water supply.

6.6.6 Public Health and Safety

Disaster Response: Cape Cod is subject to a number of natural hazards. In the Massachusetts State Hazard Mitigation Plan (Commonwealth of Massachusetts, 2018), Barnstable County received high hazard rankings for flood and coastal hazards, and medium hazard ratings for high wind, hurricane/tropical storms, thunderstorms, and Nor'easters. In Barnstable County, over the fifty year period between 1967 and 2016, there were 311 storm-event days, resulting in two deaths and 10 injuries and 118 storm-event-days with property damage (National Center for Environmental Information, 2017). Since 1990 there have been 15 Federal Disaster Declarations in Barnstable County, ten attributable to coastal storms and hurricanes, and five attributable to winter storms (Commonwealth of Massachusetts, 2013).

"Of all the natural threats that might affect Cape Cod, hurricanes have the potential to cause the most property damage and loss of life if adequate planning and preparation is not undertaken" (Cape Cod Commission 2010, p. 16). Hurricane season occurs from June first through November 30th. On average Massachusetts has one tropical storm or hurricane every other year or 0.5 storms per year. (Commonwealth of Massachusetts 2018, p. 4-204-209). Accordingly, the following discussion will focus upon disaster response in the context of hurricanes.

The estimated population (2010 population estimates) of Barnstable County that is vulnerable to hurricanes is presented in EA Table 15. The analysis indicates that 2.6 percent of Cape Cod residents would be exposed to a Category 1 possible hurricane damage, and 5.3% would be exposed to a Category 4 hurricane. Barnstable County's critical facilities, including six police stations, fourteen fire stations, and one hospital, are also exposed to hurricane hazards.

EA Table 15 - Estimated Population Exposure to Hurricane Hazard

Total Barnstable County Population	Category 1 Hurricane		Category 2 Hurricane		Category 3 Hurricane		Category 4 Hurricane	
	Population	% of Total	Population	% of Total	Population	% of Total	Population	% of Total
215, 888	5,537	2.6	8,393	3.9	10,543	4.9	11,528	5.3

From: Massachusetts State Hazard Mitigation Plan (Commonwealth of Massachusetts 2018).

Disaster response to hurricanes (and other hazards) requires "rapid and efficient egress from areas of the Cape… At the same time, Cape roadways and bridges are restricted in route options, profile, and capacity" (Commonwealth of Massachusetts, 2016, p. 3). Emergency evacuation of Cape Cod is an important issue due to the high probability of a hazardous event occurring, and because of the high traffic volume and low capacity road conditions that are exacerbated by a bottleneck created by the bridges. As of the 2010 census, there were 85,698 individuals (40% of the Barnstable County's total population) living in census tracts falling within Barnstable County's Hurricane Evacuation Zone[2]. The Cape Cod Emergency Traffic Plan outlines the various travel restrictions that may be imposed in case a large number of people need to evacuate the Cape. Such restrictions may include exit closures, detours and one-way travel on roads and bridges. The bridges may be closed if weather and traffic conditions make it unsafe to travel across them[3] (Commonwealth of Massachusetts, 2016).

Because hurricanes are the most likely hazard that would prompt disaster response, the Cape Cod Emergency Traffic Plan focuses on such a scenario, however the same approach would be applicable to other hazards. While hurricanes and tropical storms are generally tracked for some time before they reach the Cape, storm paths and intensity are uncertain, thus emergency traffic response decisions are not made until storms are 24-32 hours from landfall (Commonwealth of Massachusetts, 2016).

---

[2] I obtained this in ArcGIS by selecting census tract polygons that contain one or more MA Hurricane Evacuation Zone polygons

[3] Motorists in such a case will be shuttled to the Joint Base Cape Cod for shelter.

The Cape Cod Emergency Traffic Plan provides estimates for the amount of time it will take for residents and visitors to evacuate the Cape following a public advisory. Evacuation during a Category 3-4 Hurricane in peak tourist season will require up to 32 hours from the initiating emergency traffic response until roadways are completely clear.

EA Table 16 - Estimated Cape Clearance Times

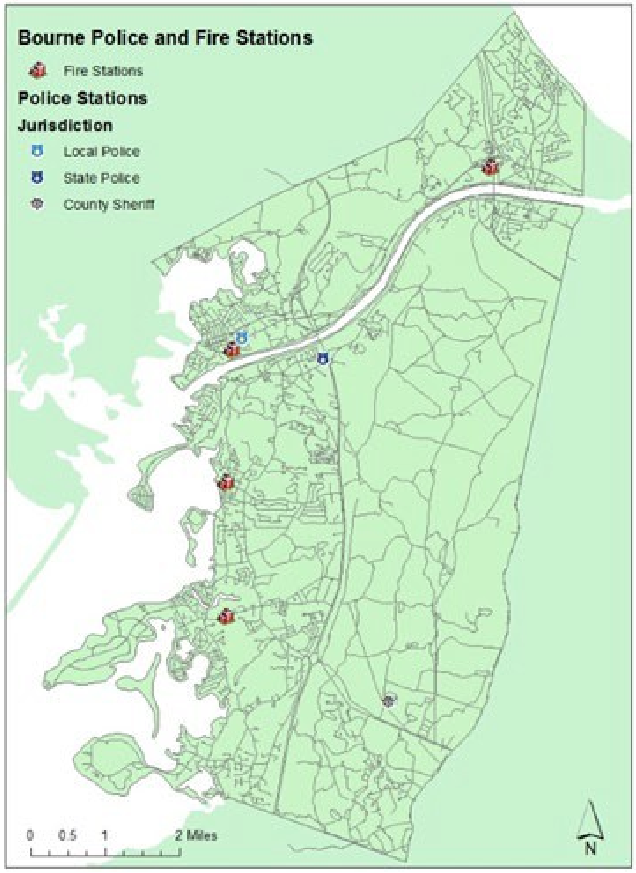
	Hurricane Category 1-2	Hurricane Category 3-4
Peak Season	22 hours	32 hours
Off-peak Season	12 hours	18 hours

Source: page 19. Cape Cod Emergency Traffic Plan (Commonwealth of Massachusetts, 2016). Calculations are based on the FEMA/USACE Massachusetts Hurricane Evacuation Study (HES – March, 2015)

Because the only vehicular access off of the Cape is via the two bridges, they create a bottleneck, limiting traffic flows. In addition, the capacity of the bridges is limited; they are thus considered a “frail lifeline” to the mainland in emergency situations (Commonwealth of Massachusetts, 2016).

Emergency Response: The town of Bourne is divided by the Cape Cod Canal; the two sides of town are accessed via the bridges. The local police department has one station located north of the bridges, fire stations are located on either side of the bridges (EA Figure 13).

EA Figure 14 - Fire and Police Stations in the Town of Bourne



Both the fire and police departments take numerous trips across the bridges each day to obtain supplies and fuel, conduct inspections and trainings, and for response to emergencies. Although the fire department has staffed stations on both sides of the bridge, they travel over the bridges approximately 10-12 times per day, on average (Bourne Deputy Fire Chief Pelonzi, personal communication. July 31, 2017). Because the local police department has only one manned station on the northern side of the bridge, they take frequent patrol trips over the bridges. The police department responds to more than 10,000 calls on the south side of the bridges every year (Bourne Police Department Lieutenant Brandon Esip, personal communication. March 13, 2018), however this number grossly underrepresents the number of police vehicles traversing the bridges. It does not account for police backup, trips back over the bridge for booking at the house of corrections or for medical services at the hospital, police on the south side that need to respond to calls on the north, or any responses to emergencies by other agencies (i.e. Fire Department, etc.).

Even without construction, increased congestion on the bridges during the summer months results in delayed emergency response (Bourne Deputy Fire Chief Pelonzi, personal communication. July 31, 2017). Inspection and training schedules need to be adapted to accommodate the increased traffic delays. In addition "when traffic causes delays, [the Bourne Fire Department is] often forced to hire additional staff on overtime to account for delays." During summer months, high traffic congestion greatly influences to which hospitals emergency responders are able to ambulate trauma victims (Bourne Deputy Fire Chief Pelonzi, personal communication. July 31, 2017). From the traffic model data used in the Economic Appendix of the accompanying MRER, the increase in summer traffic volume leads to a >75% increase in travel time from the police station to the south side of the bridges.

EA Table 17 – Change in travel time from the Bourne Police Department to the south side of the bridges

Route	Links	Travel time (min) during fall weekday	Travel time (min) during summer weekend	% increase from Fall weekday to Summer weekend
Police Dept to Cape Cod side of Sagamore Bridge via Bourne Bridge	Link 3EB + Link6SB + Link 2EB	14.7	27.2	85%
Police Dept to Cape Cod side of Sagamore Bridge via Sagamore Bridge	Link 3EB + Link 1EB + Link 9SB	13.6	24.0	76%
Police Dept to Cape Cod side of Bourne Bridge via Bourne Bridge	Link 3EB + Link 6SB	10.5	18.5	76%

Military Installations: Joint Base Cape Cod (JBCC), located in Bourne, is a military installation housing five military commands including the National Guard and Air Force (http://www.thenationsfirst.org/JBCC/index.html). Camp Edwards, part of JBCC, is New England's primary training facility for National Guard and Army Reserve soldiers. Installations at JBCC also play an important role in disaster response throughout the northeast. Currently, the two CCC bridges are the main access points for all JBCC goods and services, however some supplies are transported to the Cape via the rail system (Paul Rendon, Assistant to JBCC Director, personal communication. July 21, 2017). In addition, many JBCC personnel live off-Cape and commute to JBCC via the bridges (Paul Rendon, Assistant to JBCC Director, personal communication. July 21, 2017).

Health Services: Cape Cod Healthcare conducted a needs assessment in 2016 to identify priority areas to respond to Cape Cod residents' most urgent health needs. Chronic diseases, in particular cancer and heart disease, are the leading causes of death in Barnstable County and are accordingly identified as a topic of greatest concern (Cape Cod Healthcare, 2016). In part, this is due to greater rates of chronic diseases such as cancer and heart disease typically found in older populations. In 2011, Barnstable County's cancer incidence rate was 9% higher than Massachusetts overall (Cape Cod Healthcare, 2016).

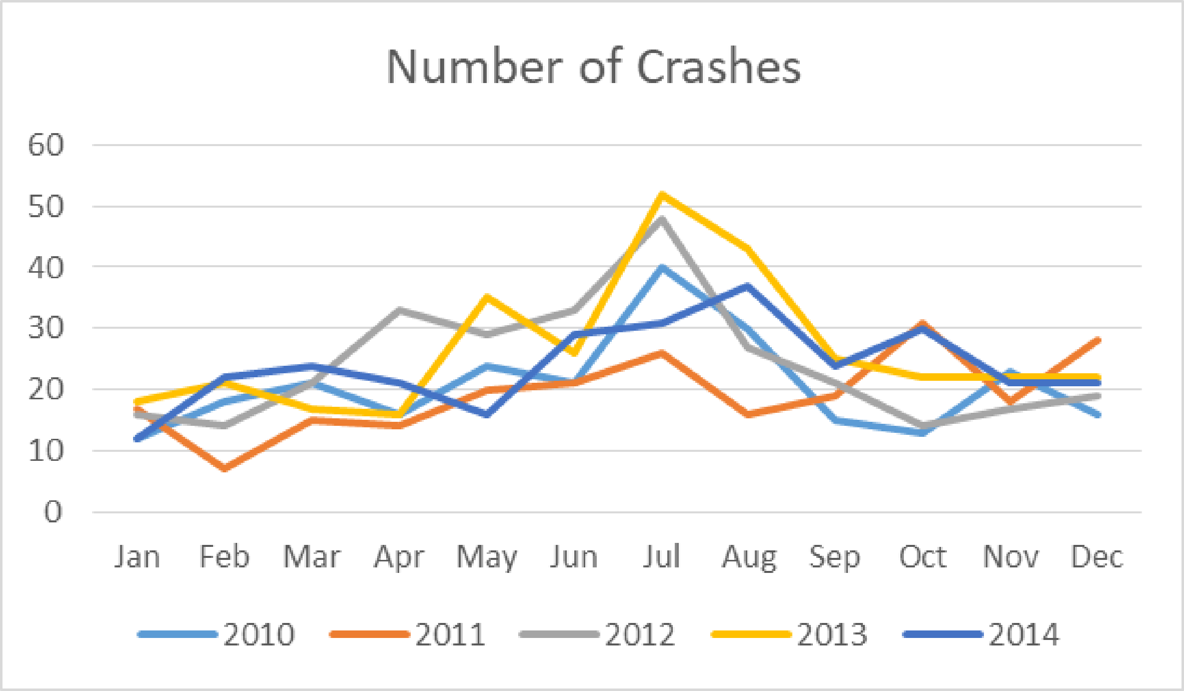
Barnstable County's population is ageing, with a greater need for health services, however the availability of health services is less than that of Massachusetts overall. For instance, the number of primary care physicians per 10,000 people is nearly 30% lower in Barnstable County compared with Massachusetts. Retirees who have moved to the Cape often prefer to stay with doctors they have an established relationship with, so they will travel off-Cape for appointments (Wendy

Northcross, CEO of the Cape Cod Chamber of Commerce, personal communication, August 8, 2017; Cape Cod Commission 2017b). In addition, there are no VA hospitals in the area, so veterans must travel to Providence or to Jamaica Plain if they wish to use VA services (Wendy Northcross, CEO of the Cape Cod Chamber of Commerce, personal communication, August 8, 2017; Cape Cod Commission 2017b). Boston's reputation for excellent, world-class health care also draws residents off of the Cape and Islands to the mainland (Wendy Northcross, CEO of the Cape Cod Chamber of Commerce, personal communication, August 8, 2017; Cape Cod Commission 2017b). Because of their distance from urban centers, Cape Cod and Islands residents face restricted access to specialty care, and often must travel to Boston, MA or Providence, RI for health care (Stasiowski, Piatt and Simpson, 2016).

In addition, there are currently no Level I or II trauma centers on Cape Cod, most trauma patients are transported to Boston hospitals for care. Currently 1,500-1,600 trauma cases each year are transported off of Cape Cod for treatment; 600-700 trauma cases are treated in local Cape Cod hospitals (Theresa Ahern, Patrick Kane and Michael Lauf; Cape Cod Healthcare, personal communication, August 2, 2017). Because transport via aircraft requires very specific conditions, much of this transport occurs via ground transportation (Cape Cod Commission, 2017b). Cape Cod Healthcare is actively seeking trauma certification and expects to receive certification after this section has been fully staffed by the end of 2020. Once certified, Cape Cod Healthcare expects to treat all Level III traumas locally but will continue to require transport to Boston hospitals for Level I traumas. (Theresa Ahern, Cape Cod Healthcare, personal communication, July 18, 2019).

Traffic Incidents: Because the bridges create bottlenecks, traffic incidents are common at the bridges' entrances. The south entrance of the Bourne Bridge and the north entrance of the Sagamore Bridge are among the Cape Cod Commission's Cape-Wide top 10 crash locations list (Cape Cod Commission, 2014). Between 2010 and 2014, there were 1380 total crashes within one mile of the two bridges; 333 resulted in non-fatal injuries and seven resulted in fatalities (MassDOT Crash Portal: accessed 7/28/2017, http://services.massdot.state.ma.us/crashportal/DataRequest.aspx). Unsurprisingly, with a greater number of vehicles on the road, there are more crashes during the summer months (EA Figure 15).

EA Figure 15 – Number of monthly crashes within one mile of the bridges (2010 – 2014)



In addition to motor vehicle incidents, the sidewalks on the bridges are not up to current federal standards and are narrower and closer in proximity to moving traffic.

Environmental Consequences

Alternative A – No Action

Though there will be no immediate impact to health and public safety, over the 50-year study period (2020-2069) as the bridge conditions deteriorate, emergency repairs will be more frequently required. This will have an impact on traffic and the ease of transport for emergency responders, access from JBCC, and for emergency evacuations. “Any closure of either of the bridges, for any amount of time, drastically impacts our ability to respond to emergencies. Long term closures would have a very negative impact on our ability to operate and respond to calls safely and efficiently” (Bourne Police Department Lieutenant Brandon Esip, personal communication. March 13, 2018). These public safety concerns associated with Alternative A could cause moderate negative impacts on the community.

Alternative B – Major Rehabilitation for Both Bridges

The Bourne and Sagamore Bridges will undergo lane closures and complete bridge closures during the rehabilitation process, influencing emergency officials’ ability to evacuate residents from the Cape during hazardous events. With partial closures, the traffic model estimates an increase in travel time over the Bourne Bridge (0.58 miles) from 1.2 minutes in the existing condition to up to 10.9 minutes during the fall weekdays and up to an hour during the summer weekends. With a full Sagamore Bridge closure the travel time over the Bourne Bridge would increase up to an hour during fall weekdays and up to four hours during summer weekends. With partial closures, the traffic model estimates an increase in travel time over the Sagamore Bridge (0.35 miles) from 0.4 minutes in the existing condition to up to 2.1 minutes during the fall weekdays and up to an hour during the summer weekends. With a full Bourne Bridge closure the travel time over the Sagamore Bridge would increase up to 21 minutes during fall weekdays and up to an hour and 45 minutes during summer weekends. These dramatic increases in travel time pertain only to the bridge segments, and do not include increased travel time on road segments leading up to the bridges. Given substantial increases in travel time associated with lane and bridge closures, a significant number of residents and visitors would likely not be able to evacuate Cape Cod prior to a major storm landfall. This could potentially lead to costly large-scale rescue efforts where residents become trapped, and may lead to additional injuries and death.

Prior incidents that have caused lane closures on the Bourne and Sagamore bridges have resulted in extensive delays in police response times (Bourne Police Department Lieutenant Brandon Esip, personal communication July 28, 2017). Lane closures due to bridge repair would have a similar effect. The National Fire Protection Association standards require first responders to be on-scene within four minutes of the first alarm, with all units arriving within eight minutes (NFPA, 2016). Although there are fire stations located on both sides of the bridges, lane closures will interfere with the Fire Department's ability to respond in a timely manner, and with adequate capacity.

Because the bridges are the primary access points for JBCC supplies and personnel, there is some concern that lane and bridge closures could limit the unit's ability to carry out their training mission (Paul Rendon, Assistant to JBCC Director, personal communication. July 21, 2017; LTC Matthew Porter, Army National Guard, Camp Edwards, personal communication. November 17, 2017). As such there would be moderate impacts to public health and safety.

Alternative D (Preferred Alternative) – Replacement of Both Highway Bridges with New Bridges - 4 Lanes and 2 Auxiliary Lanes

When the replacement bridges' construction is completed there will be a positive impact on health and public safety. The additional lanes will improve access on and off of Cape Cod during emergency evacuations. Additionally, reduced traffic eases travel constraints for emergency vehicles such as police, fire, and EMT. Safer, wider lanes will reduce traffic incidents and safer, wider pedestrian lanes will provide safer passage for pedestrians and bicyclists. . In addition, the bridges will not require continual maintenance repairs as experienced in Alternative A and B scenarios constricting traffic and safe passage.

6.6.7 Traffic

The Massachusetts Department of Transportation (MassDOT) conducted a Cape Cod Canal Transportation Study to examine current traffic conditions in the area surrounding the Sagamore and Bourne Bridges. The Army Corps of Engineers worked with a contractor, TrafInfo, to create traffic models using the MassDOT data. TrafInfo collected data for existing traffic conditions (2014) and future conditions (2040) matching the MassDOT framework. TrafInfo designed a regional travel demand model using TransCAD modeling software to capture traffic volumes at various times of the day in the existing and future conditions with partial lane closures and full bridge closures.

The study area of the traffic analysis is comprised of the Bourne and Sagamore Bridges and seven major connecting routes. More specifically, the routes which are depicted in EA Figure 16, include:

Between Bridges (East to West)

- Scenic Highway (Rt. 6): from Rt. 28 on/off ramps to Rt. 3 (where Rt. 6 and Rt. 3 merge to go over the Sagamore bridge), both directions
- Sandwich Rd: from Bourne Rotary (the intersection between Sandwich Rd and Rt. 28) to Rt. 6 ramps, both directions

North Bourne Rotary (Belmont Circle)

- Buzzards Bay Bypass (Rt. 6 and 28): from Glen Charlie Rd in Wareham to the Rt. 28 on-ramp, eastbound

Bourne Bridge entrances

- Rt. 25: From Exit 2 on Rt. 25 (Glen Charlie Rd in Wareham) to the entrance of the Bourne Bridge, southbound
- Rt. 28: From Rt. 151 (Nathan Ellis Hwy in Falmouth) to the entrance of the Bourne Bridge, northbound

Bourne Bridge

- The bridge itself south and northbound

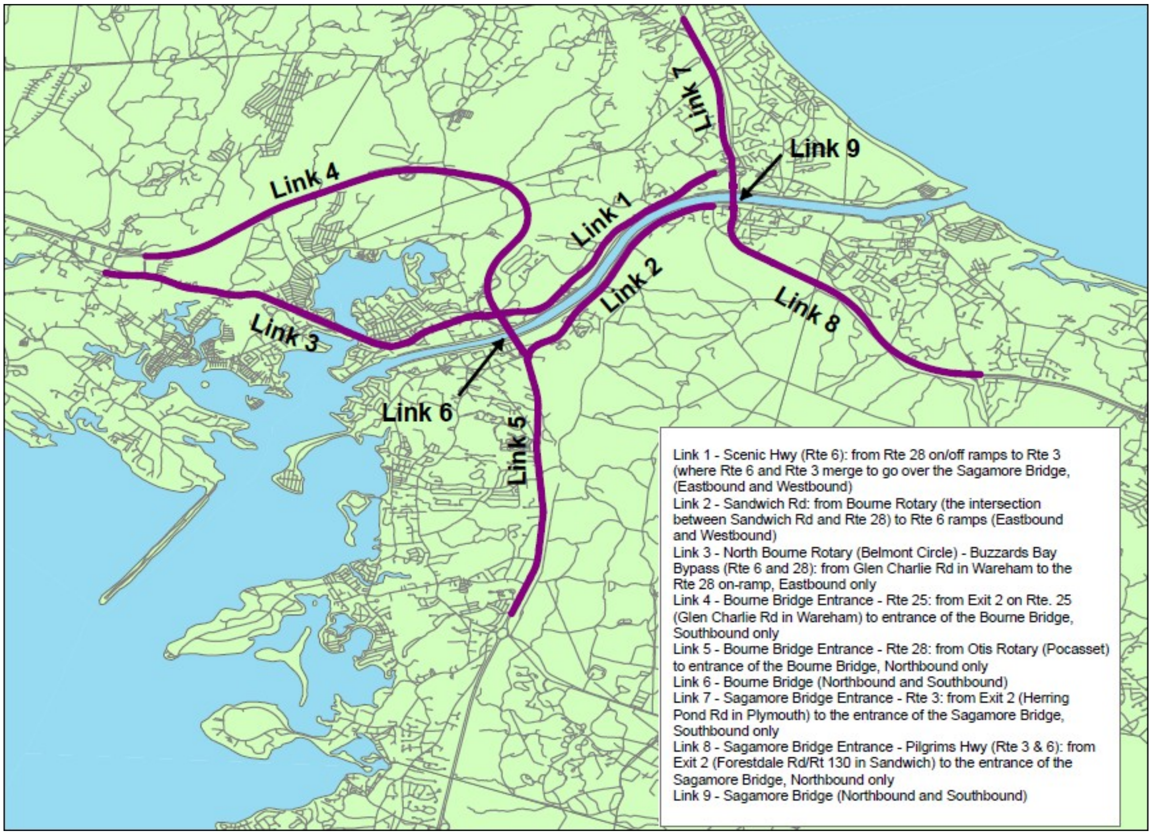
Sagamore Bridge entrances

- Rt. 3: from Exit 2 (Herring Pond Rd in Plymouth) to the entrance of the Sagamore Bridge, southbound
- Pilgrims Hwy (Rt. 3 and 6): from Exit 2 (Forestdale Rd/Rt. 130 in Sandwich) to the entrance of the Sagamore, northbound

Sagamore Bridge

- The bridge itself, south and northbound

EA Figure 16 – Traffic Routes


Link 7
Link 9
Link 4
Link 1
Link 2
Link 8
Link 3
Link 6
Link 5
Link 1 - Scenic Hwy (Rte 6): from Rte 28 on/off ramps to Rte 3 (where Rte 6 and Rte 3 merge to go over the Sagamore Bridge, (Eastbound and Westbound)
Link 2 - Sandwich Rd: from Bourne Rotary (the intersection between Sandwich Rd and Rte 28) to Rte 6 ramps (Eastbound and Westbound)
Link 3 - North Bourne Rotary (Belmont Circle) - Buzzards Bay Bypass (Rte 6 and 28): from Glen Charlie Rd in Wareham to the Rte 28 on-ramp, Eastbound only
Link 4 - Bourne Bridge Entrance - Rte 25: from Exit 2 on Rte. 25 (Glen Charlie Rd in Wareham) to entrance of the Bourne Bridge, Southbound only
Link 5 - Bourne Bridge Entrance - Rte 28: from Otis Rotary (Pocasset) to entrance of the Bourne Bridge, Northbound only
Link 6 - Bourne Bridge (Northbound and Southbound)
Link 7 - Sagamore Bridge Entrance - Rte 3: from Exit 2 (Herring Pond Rd in Plymouth) to the entrance of the Sagamore Bridge, Southbound only
Link 8 - Sagamore Bridge Entrance - Pilgrims Hwy (Rte 3 & 6): from Exit 2 (Forestdale Rd/Rt 130 in Sandwich) to the entrance of the Sagamore Bridge, Northbound only
Link 9 - Sagamore Bridge (Northbound and Southbound)

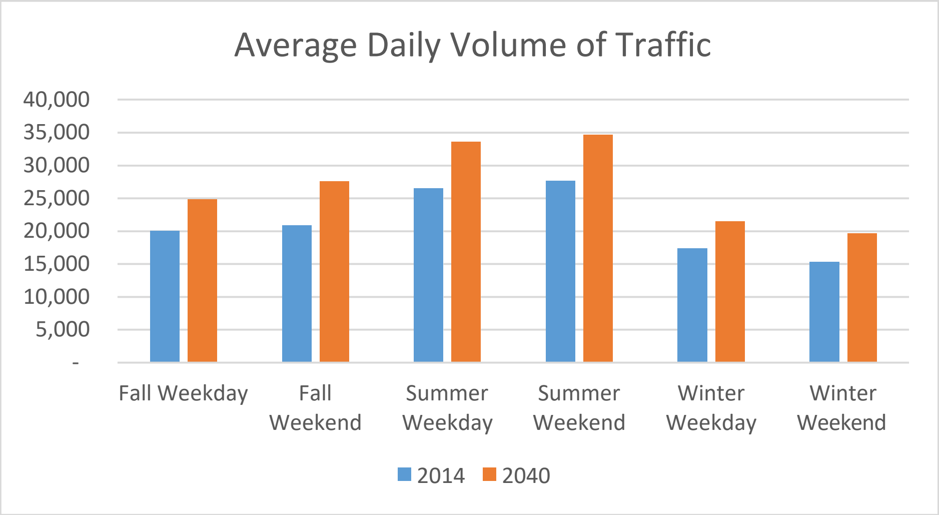
The modelers extracted data for weekdays (WD) and weekends (WE) for three seasons- summer, fall and winter (fall was used as a proxy for spring) during four daily time periods: morning (6AM-9AM; called AM), mid-day (9AM-3PM; called MD), afternoon (3PM-6PM; called PM), and night time (6PM-6AM; called NT). They ran model and extracted data under the conditions of full and partial lane closures for the Sagamore Bridge with no restrictions for the Bourne Bridge and vice versa. By definition, *partial lane* closure is described as passage of vehicles in one lane in each direction (2 lanes total) over the bridge identified under repair. While, *full lane* closure constitutes no vehicular traffic passage (0 lanes total) on the bridge identified under repair. The term "Open" denotes no lane closures associated with rehabilitation activities.

The original MassDOT Cape Cod Canal Transportation Study collected traffic data representative of summer and fall seasons, however TrafInfo modeled traffic conditions during the winter months (specifically January). Winter traffic modeling was calibrated using values input from existing data (MassDOT Canal Transportation Study and other data available through MassDOT's Traffic Collection Data Unit). Winter traffic volume and travel times were input for the four daily time periods, as well as weekends.

Conditions with no Traffic Impediments

Cape Cod is a vacation destination in the summer months, therefore, the volume of traffic increases in the summer, particularly on weekends as visitors travel on and off the Cape. EA Figure 17 displays the average daily traffic by season and day of the week (weekday or weekend). The volume of traffic is expected to increase over the forecast horizon and traffic will be at its maximum on summer weekends. Future traffic trends for visitors were projected based on data on employments trends in the Accommodations and Food Services and through discussions with the Cape Cod Commission. Future trends in non-visitor trips were escalated using population, household, and employment data. Growth in traffic is limited by maximum capacity of the roadways.

EA Figure 17 – Average Daily Volume of Traffic



Travelers over the Sagamore and Bourne bridges use 11 major routes. The 11 routes are:

1. From the mainland Route 3 to Cape Cod Route 6 via the Sagamore Bridge (2.8 miles)
2. From the mainland Route 25 to Cape Cod Route 6 via the Bourne Bridge (9.9 miles)
3. From the mainland Route 25 to Cape Cod Route 6 via the Sagamore Bridge (9.9 miles)
4. From the mainland Route 25 to Cape Cod Route 28 via the Bourne Bridge (6.9 miles)
5. From Cape Cod Route 28 to the mainland Route 25 via the Bourne Bridge (4.7 miles)
6. From Cape Cod Route 6 to the mainland Route 25 via the Sagamore Bridge (10.3 miles)
7. From Cape Cod Route 6 to the mainland Route 25 via the Bourne Bridge (7.4 miles)
8. From Cape Cod Route 6 to the mainland Route 3 via the Sagamore Bridge (4.2 miles)
9. From the mainland Belmont Circle to Cape Cod Route 6 via the Bourne Bridge (8.0 miles)
10. From the mainland Belmont Circle to Cape Cod Route 6 via the Sagamore Bridge (8.0 miles)
11. From the mainland Belmont Circle to Cape Cod Route 28 via the Bourne Bridge(5.0 miles)

Existing Areas of Congestion on Cape Cod Roadways

The following areas were identified by MassDOT as principal intersections that are the main drivers of traffic congestion in the area surrounding the Sagamore and Bourne Bridges.

Belmont Circle

Belmont Circle is a rotary north of Cape Cod Canal. The rotary connects various roadways including Scenic Highway, Main Street, Buzzards Bay Bypass, Head of the Bay Road, and ramps to Route 25. Several retail businesses and restaurants also have driveways directly from the Belmont Circle. The entrance ramp to Route 25 also leads directly to the Bourne Bridge. Travelers also often leave Route 25 at Exit 2 to access Route 6 eastbound in Wareham towards Main Street and Belmont Circle which add to traffic volumes in the Circle.

Bourne Rotary

The Bourne Rotary is located south of the Bourne Bridge with roadway approaches that include Route 28, Trowbridge Road, and the Bourne Rotary Connector. Sandwich Road provides a connection north of the rotary between Trowbridge Road and the Bourne Rotary Connector. Sandwich Roads provides a connection to Route 6.

Route 6 Exit 1C Westbound

Exit 1C, immediately after the Sagamore Bridge, is a westbound-only exit and entrance ramps to and from Cranberry Highway. The exit/entrance ramps are of substandard length at only 200 feet and grades are steep. The roadway geometry therefore contributes to congestion and delays.

Environmental Consequences

Alternative A – No Action

There would be moderate impacts to traffic as a result of the no action alternative. Traffic will progressively worsen over the 50-year period of analysis. The average travel time for a driver going over either the Sagamore Bridge or Bourne Bridge under existing conditions using one of the 11 routes described above is exhibited in EA Table 18 below. Note that this includes only the length of the routes described (average 7.6 miles

directly correlated to bridge traffic) not the total travel time drivers experience over their entire journey.

EA Table 18 – Average Travel Time of Major Routes

Average Travel Time (min)								
	Fall Weekday				**Fall Weekend**			
	AM	**MD**	**PM**	**NT**	**AM**	**MD**	**PM**	**NT**
Base Condition - 2014	9.5	9.0	9.8	8.9	9.1	9.2	9.6	8.9
Base Condition - 2040	9.9	9.1	10.4	9.0	9.3	9.5	10.6	9.2
	Summer Weekday				**Summer Weekend**			
	AM	**MD**	**PM**	**NT**	**AM**	**MD**	**PM**	**NT**
Base Condition - 2014	9.8	9.5	10.2	9.0	10.0	15.2	14.7	9.3
Base Condition - 2040	10.5	10.1	11.4	9.4	10.7	19.2	19.5	10.3
	Winter Weekday				**Winter Weekend**			
	AM	**MD**	**PM**	**NT**	**AM**	**MD**	**PM**	**NT**
Base Condition - 2014	9.7	8.9	9.5	8.8	8.9	9.0	9.1	8.8
Base Condition - 2040	10.1	8.9	9.9	8.9	9.0	9.0	9.4	8.9

MD = midday; NT = night time
Weekend=Saturday and Sunday

These travel times reflect the anticipated regular flow of traffic. In reality, during the no-action alternative the bridges will require more frequent construction projects to maintain the bridges in working condition. These projects will require lane closures (partial closures) and full bridge closures. The impact of the lane and bridge closures are described in EA Tables 19 and 20 and a description of the type of emergency repair and associated travel restrictions is presented in EA Table 21. The further out in the study period, the more frequent emergency repair projects will be required and in turn closures increasing impact and delays.

EA Table 19 - Average Travel Time by Closure 2014

Average Travel Time in (min) 2014						
	Fall		Summer		Winter	
Alternatives	**Weekday**	**Weekend**	**Weekday**	**Weekend**	**Weekday**	**Weekend**
Existing Hwy	9.3	9.2	9.6	12.3	9.3	9.0
Partial Bourne	12.3	12.3	14.5	25.5	12.1	10.3
Full Bourne	16.6	15.7	20.8	37.0	16.3	13.0
Partial Sagamore	9.8	9.5	11.7	30.5	9.9	9.0
Full Sagamore	19.1	18.5	40.0	77.6	18.0	12.5
Difference (min)						
Alternatives	**Weekday**	**Weekend**	**Weekday**	**Weekend**	**Weekday**	**Weekend**
Existing Hwy	-	-	-	-	-	-
Partial Bourne	3.0	3.1	4.9	13.2	2.8	1.4
Full Bourne	7.3	6.5	11.2	24.8	7.1	4.0
Partial Sagamore	0.5	0.3	2.1	18.2	0.6	0.0
Full Sagamore	9.8	9.3	30.4	65.3	8.7	3.5

EA Table 20 - Average Travel Time by Closure 2040

Average Travel Time in (min) 2040						
	Fall		Summer		Winter	
Alternatives	**Weekday**	**Weekend**	**Weekday**	**Weekend**	**Weekday**	**Weekend**
Existing Hwy	9.6	9.6	10.3	14.9	9.5	9.1
Partial Bourne	15.8	23.5	61.8	85.2	21.9	11.4
Full Bourne	25.2	26.2	53.5	76.1	27.4	16.6
Partial Sagamore	31.5	32.3	85.3	106.2	31.2	10.8
Full Sagamore	47.8	58.8	125.6	177.2	59.8	29.6
Difference (min)						
Alternatives	**Weekday**	**Weekend**	**Weekday**	**Weekend**	**Weekday**	**Weekend**
Existing Hwy	-	-	-	-	-	-
Partial Bourne	6.2	13.9	51.5	70.3	12.4	2.4
Full Bourne	15.6	16.6	43.2	61.2	17.9	7.5
Partial Sagamore	21.9	22.7	75.0	91.3	21.7	1.7
Full Sagamore	38.2	49.2	115.3	162.2	50.4	20.5

EA Table 21 - Emergency repair and associated travel restrictions

Description	Lane Closures
Superstructure	
Advanced deterioration of secondary member, non-critical Gusset Plate, Stringer, Floorbeam, or Hanger Cable	9 months lane closure - no closures Memorial Day to Columbus Day
Advanced deterioration of Main Truss Member or Critical Gusset Plate	18 months lane closures
Catastrophic Damage to Main Truss Member or Critical Gusset Plate	60 Months Bridge Closure
Substructure	
Localized Concrete Defects such as Cracks or Spalls on Vertical Surfaces of Piers or Degradation of Concrete under Bearings on the Piers	6 months of lane closures, no closures Memorial Day to Columbus Day, Lane Closures limited to non-peak hours, weekdays
Widespread Concrete Defects such as Cracks or Spalls on Vertical Surfaces of Piers or Degradation on Concrete under Bearings on the Piers	12 months of lane closures, no closures Memorial Day to Columbus Day, Lane Closures limited to non-peak hours, weekdays
Bridge Deck	
Localized deterioration of Roadway Joint(s), Granite Curbs, Concrete-filled Steel Grid over Bridge Spans, or Reinforced Concrete Deck at Abutments	6 months of lane closures, no closures Memorial Day to Columbus Day
Widespread Deterioration of Concrete-filled Steel Grid Deck over Bridge Spans and Reinforced Concrete Deck at the Abutments	15 Months of Temporary Lane Closures on one Bridge, no Closures Memorial Day to Columbus Day

Alternative B – Major Rehabilitation for Both Bridges

During the major rehabilitation, expected lane or bridge closures are described in EA Table 22 below. The individual driver impact of each day of bridge or lane closure is described in the EA Tables 19 and 20 (above).

Therefore during the major rehabilitation project there will be substantial delays to traffic due to months of lane or bridge closures over the years of construction. After the major rehabilitation project, the safety of the bridges will improve and therefore require less frequent emergency repairs (as described in EA Table 21). However, given that the bridges are aging, these emergency repairs will occur at a rate less frequently than the no-action alternative but at a higher frequency than with replacement bridges.

EA Table 22 - Rehabilitation Lane Closure Duration Estimates

MAJOR REHAB ACTIVITY	BOURNE	SAGAMORE
	LANE CLOSURE DURATION (DAYS)	
BRIDGE SUPERSTRUCTURE DECK REPLACEMENT (INCLUDING STRINGER REPLACEMENT); ABUTMENT SPAN REPLACEMENT; (CONCRETE T-BEAMS) MISC. STEEL REPAIRS, ETC.; EXTERIOR GUSSET PLATE RETROFITS; INTERIOR GUSSET PLATE REPAIRS; MISC. CONCRETE REPAIRS, ETC.	165	135
SUSPENDER CABLE REPLACEMENT	65	70
PAVING	30	25
PAINTING	220	150
TOTAL DAYS OF LANE CLOSURES	**480**	**380**
	FULL BRIDGE CLOSURE DURATION (DAYS)	
INTERIOR GUSSET PLATE REPLACEMENT	70	95
FLOORBEAM REPLACEMENT	110	35
TOTAL DAYS OF FULL BRIDGE CLOSURE	**180**	**130**

Alternative D (Preferred Alternative) – Replacement of Both Highway Bridges with New Bridges - 4 Lanes and 2 Auxiliary Lanes

The replacement bridge alternative will not have a notable impact on traffic flows during construction as the bridges will be built adjacent to the existing bridges. The new replacement bridges will require eight weeks of lane closures for scheduled maintenance every twenty years and then again after forty years. In this alternative the lanes of the replacement bridge will be wider making the bridges safer and the additional auxiliary on/off lane will ease some of the traffic congestion. Improvements to traffic congestion will be constrained by the road systems surrounding the bridges therefore in order for the full impact of the traffic alleviation to occur, MassDOT will need to improve the infrastructure surrounding the bridge, most notably the Bourne Rotary. Specific MassDOT recommended improvement projects are discussed in the Cumulative Impacts Section of this EA.

The replacement bridges are expected to reduce traffic congestion but will not be a driver in increased volume for more visitors on Cape Cod. The traffic analysis includes an estimate for increased visitors on the Cape with or without replacement of the bridges. Visitor trips were projected using an annual growth rate of 0.7% or a factor of 1.2 between 2014 and 2040. As part of MassDOT's Cape Cod Canal Transportation Study, a detailed assessment was conducted into employment trends in Accommodations and Food Services as a proxy for visitor activity. A regression model was developed relating employment in Accommodations and Food Services with traffic volumes over the Bourne and Sagamore bridges. The analysis indicated the visitor growth to be in the range of 0.12% to 0.7%. Based on discussions with the Cape Cod Commission and their in-house estimates of visitor growth, the high end growth rate was used to allow for a more conservative analysis of the necessary highway improvements and to ensure the growth potential in the Cape was not constrained by the proposed highway infrastructure. Therefore, it is expected that visitor growth is linked to the tourism industry through accommodations and food services rather than road improvements.

6.6.8 Environmental Justice

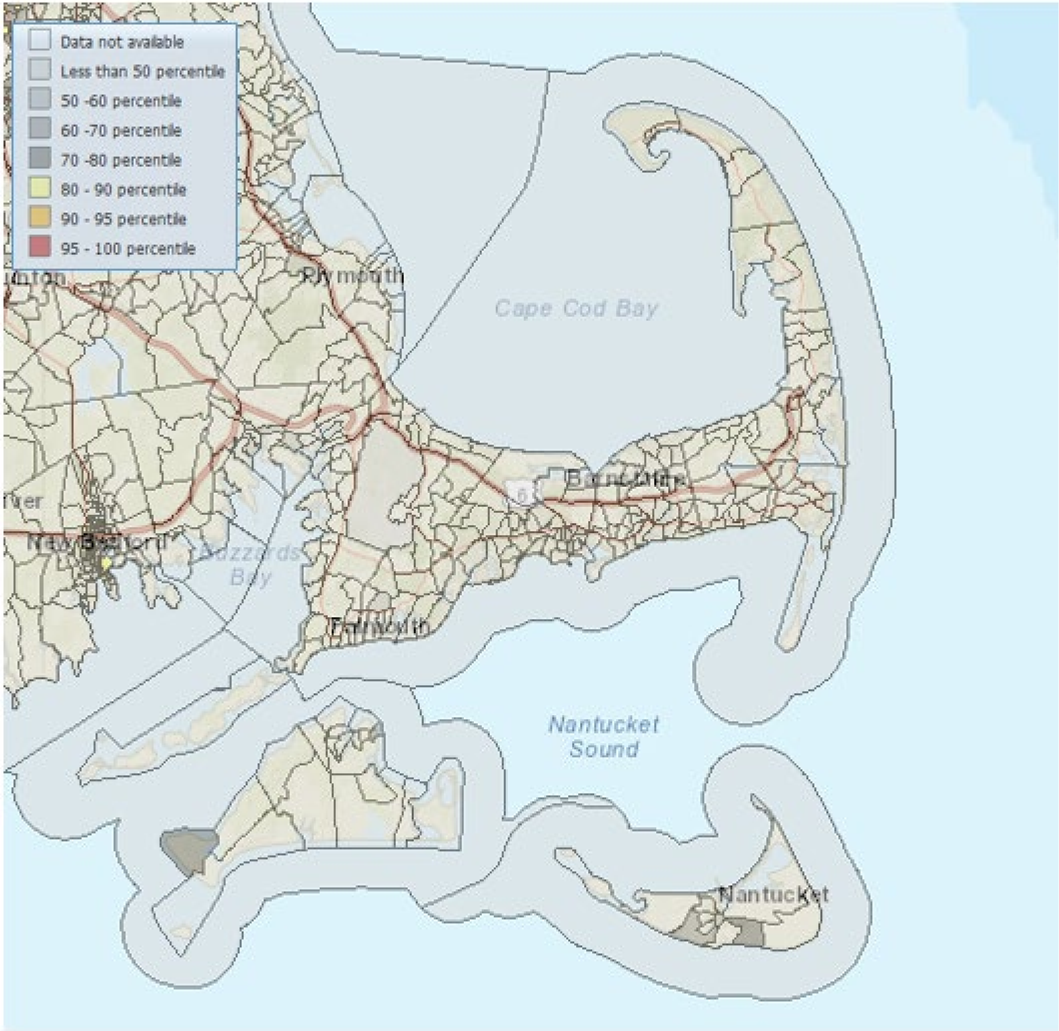
It is important that any construction project under consideration by the federal government ensures that it does not negatively impact socially vulnerable populations. The Environmental Protection Agency (EPA) defines Environmental Justice as the "the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income, with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies". Impacts to vulnerable populations as pertaining to Environmental Justice were evaluated in accordance with Executive Order 12898 – *Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations* signed February 16, 1994. Executive Order 12898 directs federal agencies to identify and address the disproportionately high and adverse human health or environmental effects of their actions on minority and low-income populations, to the greatest extent practicable and permitted by law (EPA, 2019b).

The EPA has developed an Environmental Justice Screening Tool (EJScreen) which identifies areas of environmental and social vulnerability by census block using data sourced from the US Census Bureau's American Community Survey, 2012-2016.

Minority Population: The EJScreen has a map capability that views minority population as a percentile of the nation, e.g. 60 percentile of a minority population in the census block means that the minority population is higher than 60% of the nation's census blocks.

EA Figure 18, below exhibits the minority population (national percentiles) by census block for Cape Cod and the Islands. The population is majority white, with only a few pockets of the population with a percentile greater than 50 on Martha's Vineyard, Nantucket, Falmouth, and Barnstable.

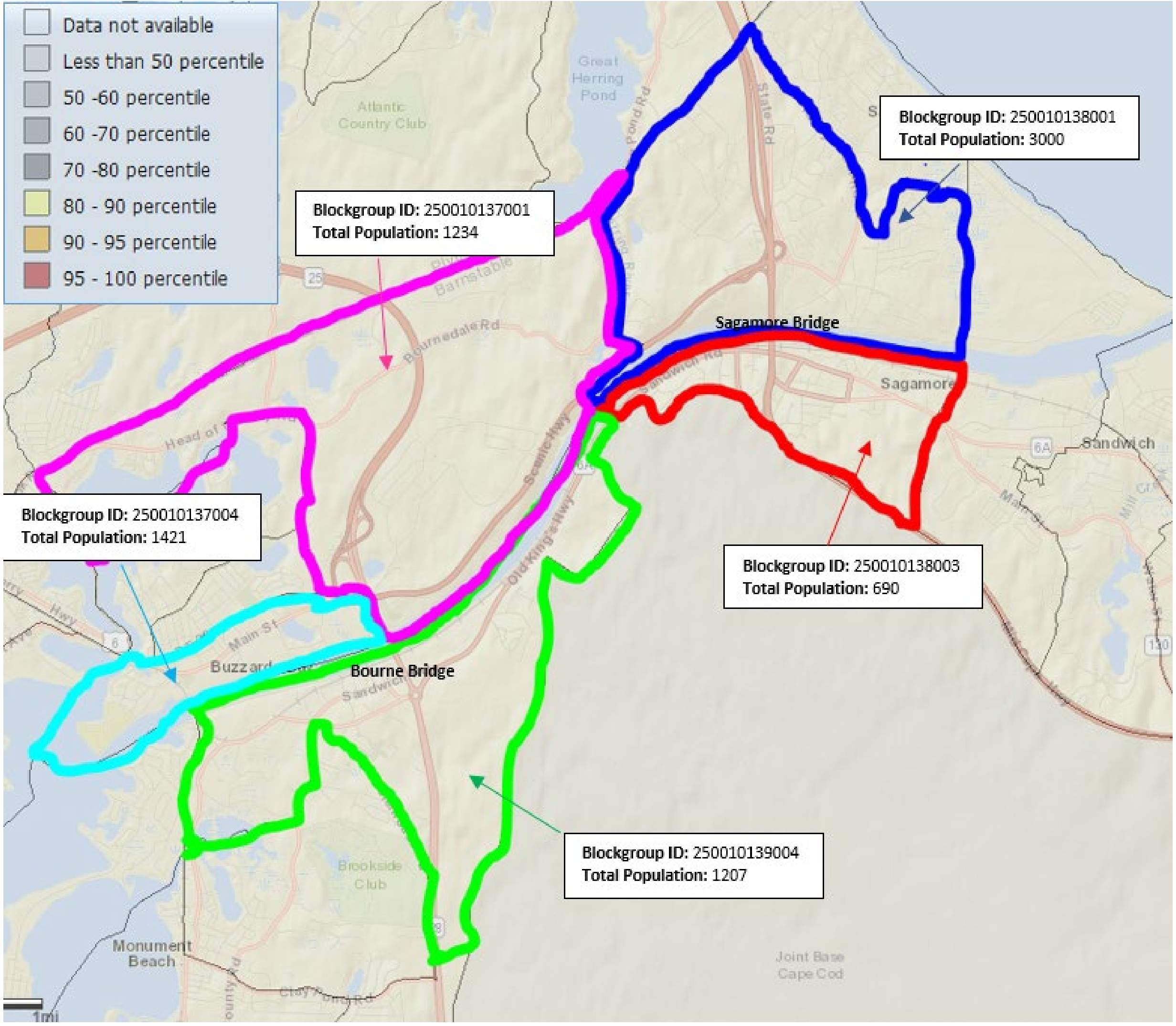
EA Figure 18 - Minority Population in Cape Cod and Islands, National Percentiles



Source: EPA, EJScreen

The study area is located across two census block groups surrounding the Sagamore Bridge and three census block groups surrounding the Bourne Bridge. EA Figure 19, below shows the focused study area, which has no census block with a minority population higher than 50 percentile in the nation.

EA Figure 19 - Minority Population in the Study Area, National Percentiles



Source: EPA, EJScreen

The EPA defines percent minority as “a fraction of population, where minority is defined as all but Non-Hispanic White Alone” and is calculated using data from the US Census, American Survey. The percent minority population of the census block groups in the project area were compared to the minority population in Massachusetts and the national average. EA Table 23, below, summarizes the results.

EA Table 23 – Percent Minority

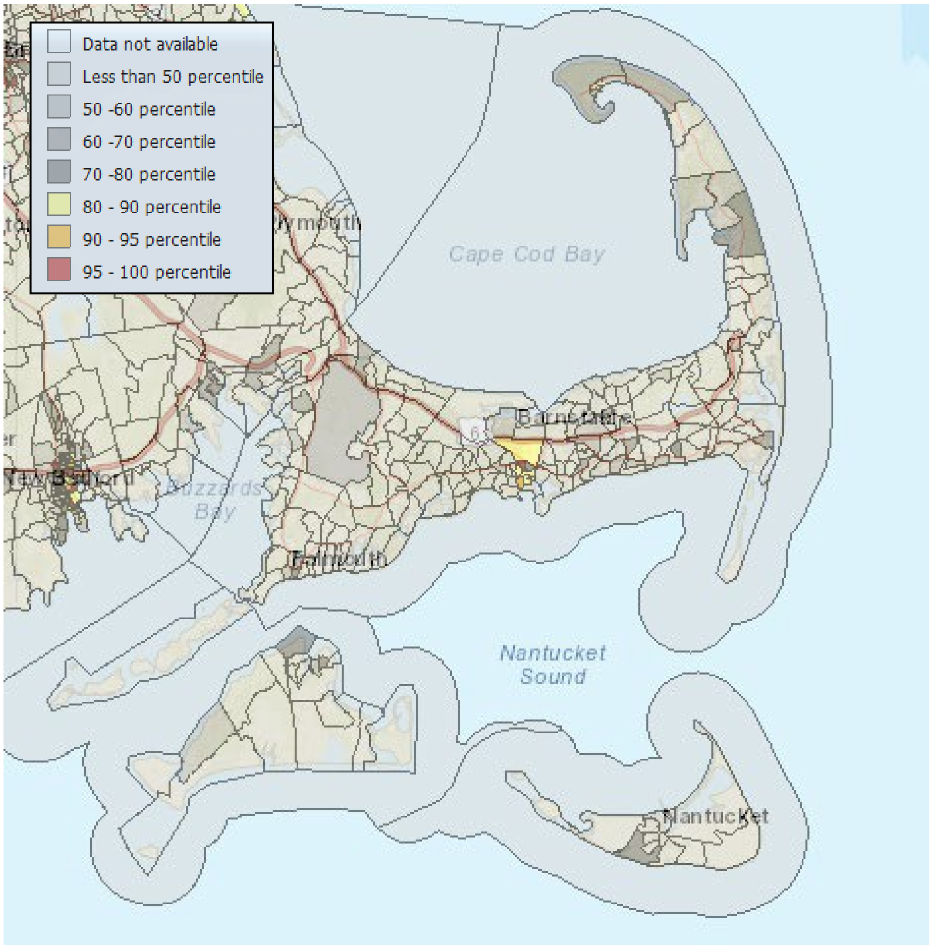
	Percent Minority
Sagamore Bridge	
250010138001	9%
250010138003	0%
Bourne Bridge	
250010137004	21%
250010137001	3%
250010139004	3%
Massachusetts	21%
United States	27%

None of the study block groups in the project area exceed the percent minority in the state or national average. Therefore, the population in the study area is not considered socially vulnerable as pertaining to minority population.

Low-Income Population: The EPA EJScreen also has a map capability to view the low-income population as a percentile of the nation, e.g. 60 percentile of low-income population in the census block means that the low-income population is higher than 60% of the nation's census blocks. Low-income population is defined by the EPA as the "percent of individuals whose ratio of household income to poverty level in the past 12 months was less than 2" and is calculated using data from the Census Bureau's American Community Survey.

EA Figure 20 below exhibits the low-income (as a national percentile) by census block for Cape Cod and the Islands. Low-income populations are more prevalent in the region as compared to minority populations. The highest concentration on low-income population is in the town of Barnstable.

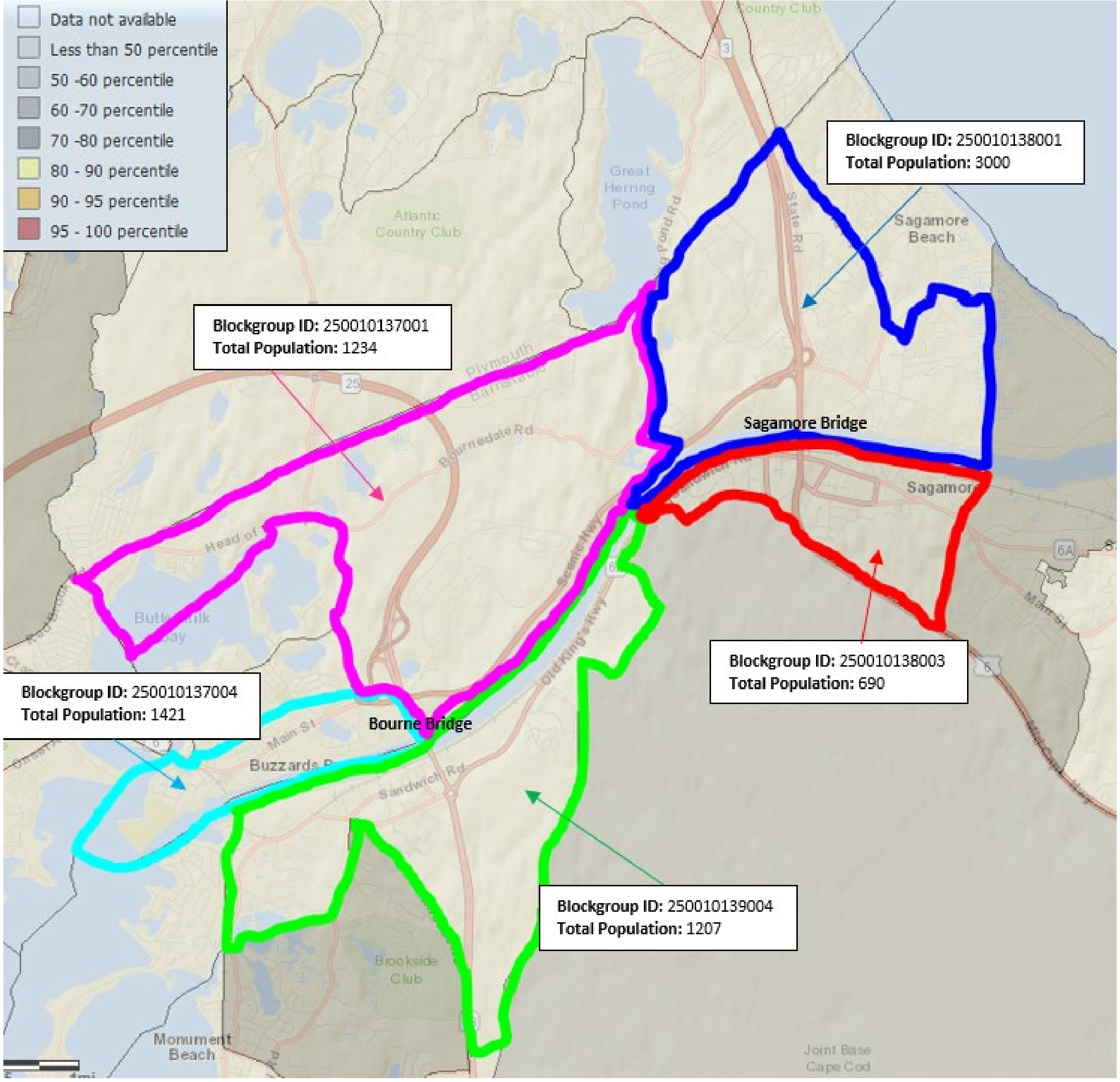
EA Figure 20 - Low-Income Population in Cape Cod and Islands, National Percentiles



Source: EPA, EJScreen

The same census block groups were used to evaluated the low-income population impacted by the proposed bridge projects. EA Figure 21 below shows the focused study area, which has no census block with a low-income population higher than 50 percentile in the nation.

EA Figure 21 - Low-Income in the Study Area, National Percentiles



Source: EPA, EJScreen

EA Table 24 below compares the block group median household income from the Census Bureau’s American Community Survey.

EA Table 24 – Median Household Income

	Number Persons per Household	**Median Household Income**
Sagamore Bridge		
250010138001	2.5	$78,830
250010138003	2	$82,802
Bourne Bridge		
250010137004	3	$77,500
250010137001	2.5	$76,250
250010139004	2.5	$79,773
Massachusetts	2.5	$74,167
United States	2.5	$57,652

The median income of the households in the study are above the Massachusetts average and the average of the United States. According to the Health and Human Services (HHS) Poverty Guideline, the poverty threshold is $16,910 for a two person household and $21,330 for a three person household. All block groups in the study area are well above this poverty threshold. Therefore, the project will not negatively impact populations that are socially vulnerable due to low-income.

Environmental Consequences

Alternative A – No Action, Alternative B – Major Rehabilitation for Both Bridges, and Alternative D (Preferred Alternative) – Replacement of Both Highway Bridges with New Bridges - 4 Lanes and 2 Auxiliary Lanes

Given that the population surrounding the bridges is not considered socially or environmentally vulnerable, each project is not expected to have a negative impact on low-income or minority populations.

6.6.9 Hazardous Materials and Waste

This section discusses human health hazards due to exposure to existing and potential future sources of hazardous materials and wastes due to project construction and operation.

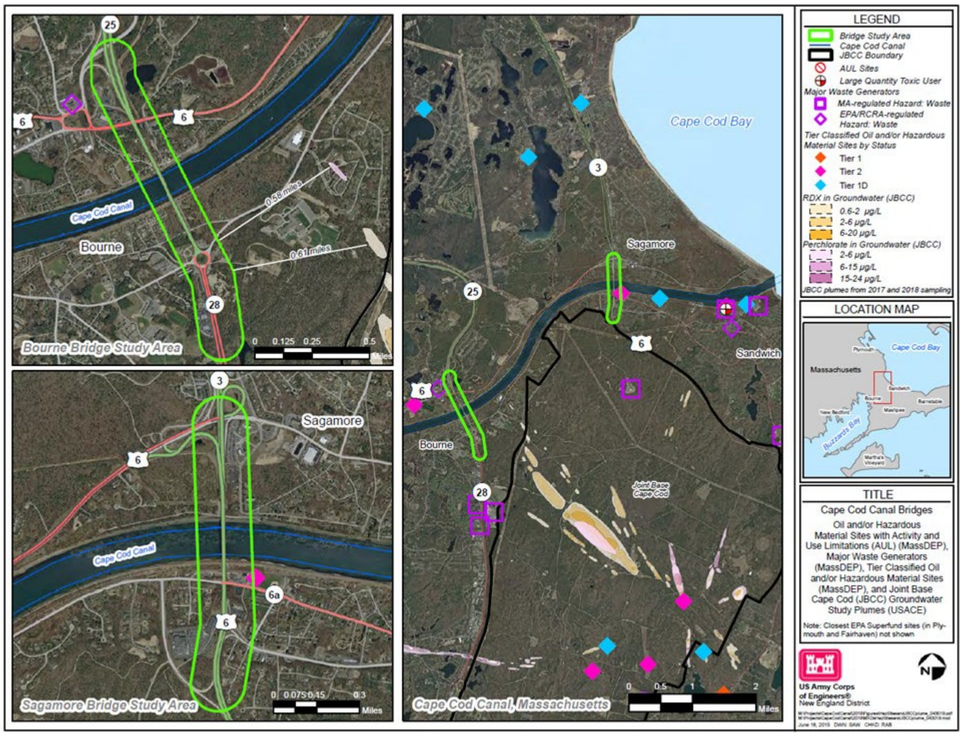
Hazardous substances are defined as any solid, liquid contained gaseous or semisolid waste, or combination of wastes that pose a substantial present or potential hazard to human health and the environment. Improper management tor disposal of hazardous substances can lead to contamination of soils, surface water, or groundwater.

The primary federal regulations for the management and disposal of hazardous substances are the Comprehensive Environmental Response and Liability Act (CERCLA), more commonly known as Superfund, and the Resource Conservation and Recovery Act (RCRA) (42 U.S.C. 6901 et seq., 1976). The purpose of CERCLA is to clean up contaminated sites and reduce impacts to public health and the environment. RCRA regulates the proper transport, treatment, storage and disposal of hazardous waste from “Cradle to Grave”. EPA is the agency responsible for developing regulations, guidance, and policies for the management and cleanup of solid and hazardous waste and ensuring proper handling of hazardous waste.

The MA Department of Environmental Protection (MA DEP) maintains a statewide database of all oil and/or hazardous material releases and disposal sites classified under MA General Law Chapter 21E and the Massachusetts Contingency Plan (MCP). A review of this database was conducted to identify any listed sites that might have the potential to impact, or be affected by, the project. The database search area extended 4.5 miles north of the canal, 6-6.5 miles south of the canal, 2.5 miles east of the Sagamore Bridge, and 0.81 miles west of the Bourne Bridge. (EA Figure 22). Sites beyond these distances are unlikely to have potential to impact the project.

Results of the database search revealed only one listed site *Pairpoint Glassworks* abutting the Sagamore Bridge study area and a *CVS*, listed as an EPA/RCRA regulated hazardous waste generator, as the closest site to the Bourne Bridge (0.11 miles).

EA Figure 22 - Hazardous sites and groundwater study plumes in the study area


Bourne
Cape Cod Canal
0.58 miles
0.81 miles
Bourne Bridge Study Area
0 0.125 0.25 0.5 Miles
Sagamore
Sagamore Bridge Study Area
0 0.075 0.15 0.3 Miles
Cape Cod Bay
Sagamore
Sandwich
Bourne
Joint Base Cape Cod
Cape Cod Canal, Massachusetts
0 0.5 1 2 Miles
LEGEND
Bridge Study Area
Cape Cod Canal
JBCC Boundary
AUL Sites
Large Quantity Toxic User
Major Waste Generators
MA-regulated Hazard: Waste
EPA/RCRA-regulated Hazard: Waste
Tier Classified Oil and/or Hazardous Material Sites by Status
Tier 1
Tier 2
Tier 1D
RDX in Groundwater (JBCC)
0.6-2 µg/L
2-6 µg/L
6-20 µg/L
Perchlorate in Groundwater (JBCC)
2-6 µg/L
6-15 µg/L
15-24 µg/L
JBCC plumes from 2017 and 2018 sampling
LOCATION MAP
Plymouth
Cape Cod Bay
Massachusetts
Sandwich
Bourne
Barnstable
New Bedford
Mashpee
Buzzards Bay
Martha's Vineyard
TITLE
Cape Cod Canal Bridges
Oil and/or Hazardous Material Sites with Activity and Use Limitations (AUL) (MassDEP), Major Waste Generators (MassDEP), Tier Classified Oil and/or Hazardous Material Sites (MassDEP), and Joint Base Cape Cod (JBCC) Groundwater Study Plumes (USACE)
Note: Closest EPA Superfund sites (in Plymouth and Fairhaven) not shown
N
US Army Corps of Engineers® New England District
June 18, 2019 DWN: SAW CHKD: RAB

CERCLA: Proximity to USEPA Superfund Sites and Groundwater Contamination: The nearest Superfund Site, as regulated by the US EPA under CERCLA, listed in the National Priorities List (NPL) is Joint Base Cape Cod (JBCC) formerly known as the Massachusetts Military Reservation located approximately 1 mile southeast of the Bourne and 2 miles south of the Sagamore proposed bridge projects.

JBCC is located over a sole source aquifer that provides drinking water to 200,000 year-round and 500,000 seasonal residents of Cape Cod. Portions of the aquifer have been contaminated due to fuel spills, training exercises, improper disposal, and other past activities at JBCC's Camp Edwards and Otis Air National Guard Base. (EPA, 2019).

Perchlorate and RDX are the primary contaminants of concern at the JBCC Superfund site. The closest plume to the proposed bridges project area is 2.2 miles from edge of the Perchlorate plume and 1.7 miles from edge of closest RDX plume to the closest edge of Sagamore bridge study area; and 0.58 miles from edge of Perchlorate plume and 0.6 miles from edge of closest RDX plume to the closest edge of Bourne bridge study area (EA Figure 20). Ongoing remediation at the site is being addressed through both Federal and state actions.

Environmental Consequences

Alternative A – No Action, Alternative B – Major Rehabilitation for Both Bridges, , and Alternative D (Preferred Alternative) – Replacement of Both Highway Bridges with New Bridges - 4 Lanes and 2 Auxiliary Lanes

No project alternative will affect any listed hazardous waste sites. No contaminated soils or groundwater will be exposed as a result of proposed project alternatives including routine maintenance, major rehabilitation, or replacement, and none of these activities will be impacted by ongoing remediation at the JBCC Superfund site. The closest contaminated groundwater plume is located outside of the project area and would not be affected by the proposed project.

RCRA: Proper handling and disposal of hazardous waste

Handling, management, and disposal of any petroleum products, hazardous materials, and/or hazardous and solid waste will be in accordance with all applicable Federal, State, and Local regulations and compliance requirements.

Alternative A – No Action and Alternative B – Major Rehabilitation for Both Bridges

No project alternative will affect any listed hazardous waste sites. No contaminated soils or groundwater will be exposed as a result of proposed project alternatives including routine maintenance, major rehabilitation, or replacement, and none of these activities will be impacted by ongoing remediation at the JBCC Superfund site. The closest contaminated groundwater plume is located outside of the project area and would not be affected by the proposed project.

RCRA: Proper handling and disposal of hazardous waste

Handling, management, and disposal of any petroleum products, hazardous materials, and/or hazardous and solid waste will be in accordance with all applicable Federal, State, and Local regulations and compliance requirements.

Routine maintenance and emergency repairs as well as major rehabilitation may include the removal/sandblasting of lead containing paint from the Sagamore and Bourne Bridges. During the design and construction phase best management practices, construction specifications, and a waste disposal plan will be developed to ensure the proper handling and disposal of all hazardous and nonhazardous waste generated during the project. Waste generated from abrasive blasting and lead-containing paints will be disposed of as a hazardous waste. All hazardous waste shall be transported by a licensed transporter. All nonhazardous waste will be transported in accordance with local regulations regarding waste transportation.

Alternative D (Preferred Alternative) – Replacement of Both Highway Bridges with New Bridges - 4 Lanes and 2 Auxiliary Lanes

During the construction phase of new bridges, protective measures will be taken to address all hazardous material potential impacts and will include appropriate work and construction specifications to protect worker health and safety, and to ensure proper handling and disposal of contaminated materials and demolition waste (lead-based paint).

6.6.10 Noise

Noise is unwanted sound. In a community, noise can originate from a variety of sources including transportation (automobiles, trucks, buses, trains, and aircraft), stationary sources (manufacturing facilities, HVAC systems, and utility operations), natural sources (animals, insects, and wind) and from people (talking and just going about their business). Environmental noise is composed of sounds from moving as well as stationary sources, and varies from place to place and from time to time. Land use in the general area of the bridges varies from mixed business, commercial, recreation and residential properties.

The EPA has developed federal noise-emission standards, identifying major sources of noise and determining appropriate noise levels for activities that would infringe on public health and welfare (EPA, 2009). The "Levels Document" is the standard reference in the field of environmental noise assessment. EPA identifies a 24-hour exposure level of 70 decibels (dB) as the level of environmental noise, which will prevent any measurable hearing loss over a lifetime. Levels of 55 dBs outdoors and 45 dBs indoors are identified as "preventing activity interference and annoyance". U.S. Department of Transportation (USDOT) has established acceptable noise levels and ranges for construction equipment (USDOT, 2018).

The Noise Control Act of 1972 establishes a national policy to promote an environment for all Americans free from noise that jeopardizes their health and welfare. The act establishes a means for effective coordination of federal research and activities in noise control, authorizes the establishment of federal noise emission standards for products distributed in commerce, and provides information to the public respecting the noise emission and noise reduction characteristics of these products. The act authorizes and directs that federal agencies, to the fullest extent consistent with their authority under federal laws administered by them, carry out the programs within their control in such a manner as to further the policy declared in the Act. Each department, agency, or instrumentality of the federal government having jurisdiction over any property or facility or engaged in any activity resulting, or which may result in, the emission of noise shall comply with federal, state, interstate, and local requirements respecting control and abatement of environmental noise.

Both the Bourne and Sagamore Bridges are located almost entirely within the town of Bourne. The project area includes transportation infrastructure, residential and commercial properties, and forested land (Refer to EA Figure 3 in Section 6.1.1) and "Land Use and Zoning" in Section

6.6.3.

The study area within Bourne's downtown is positioned roughly between the Cape Cod Canal Railroad Bridge and the Bourne Bridge on the northern (mainland) side of the canal (EA Figure 3). The downtown area is zoned for a variety of uses, including higher-density public works, landscaping, construction, and retail facilities. Other parts of the downtown area are zoned for natural resource protection. Much of the area abutting the Bourne Bridge is zoned for residential use or protected forest. Adjacent to the Sagamore Bridge is the South Sandwich Village Center (SSVC), which is home to 130 acres of retail, restaurant, entertainment, and professional office space. An adjacent 114-acre parcel owned by the Commonwealth serves as a protected wildlife habitat and the study area of this project also goes through areas zoned for residential and industrial use.

Replacement bridges would be constructed adjacent to the existing Bourne and Sagamore Bridges. The project area will be more clearly defined in Phase II of the project.

Environmental Consequences

MassDOT's *Cape Cod Canal Transportation Study* (2019) describes anticipated noise impacts in the proposed project area by using the worst-case existing and future traffic conditions (i.e. highest traffic volumes found during the summer Saturday peak period) to correlate to higher (i.e. worst case) noise impacts at noise sensitive locations (mostly residential neighborhoods). MassDOT modeled increases in the hourly sound level from the 2014 Existing to 2040 Build conditions were for all three peak hours. The range of increases and the peak hour with the highest increase were reported for the areas near residential land use. For reference, a sound level increase of three decibels or less is generally not noticeable under most circumstances. An increase of five dB is generally noticeable in a community setting. An increase of 10 dB is perceived by most people as about twice as loud. Also, MassDOT' s Noise Policy considers an increase of 10 dB or more above existing noise levels to be a "substantial increase" that would require consideration of abatement in a final environmental document (MassDOT, 2019).

They determined predicted sound level increases would be small for most roadways, generally less than three decibels, which is expected to be generally not noticeable Changes in traffic patterns at some locations could result in increases up to six decibels. 'These are expected to be readily noticeable, but not approach a 'substantial increase' per MassDOT policy (MassDOT, 2019).

Alternative A – No Action

Under the No Action Alternative, there would be no change in ambient noise levels associated with routine bridge maintenance. Noise levels resulting from existing traffic or from surrounding land use activities would remain the same.

Alternative B – Major Rehabilitation for Both Bridges

Major Rehabilitation would generate noise from repairs, equipment, and any needed construction-related activities. Mitigation would be accomplished by complying with conditions in construction permits or town ordinances to address short term increases in noise. Therefore, there would be only minor impacts to noise under the Major Rehabilitation alternative.

Additionally, this project alternative would have no effect on federally listed species, except for the Northern Long-Eared Bat (NLEB) which may roost under the bridges. The USACE will consult with USFWS pursuant to Section 7 of the Endangered Species Act (ESA) to determine if NLEB are present and identify measures necessary to minimize potential noise impacts to this species in Phase II of the project. Please reference the Threatened and Endangered Species (Section 6.4.4 of this document for a discussion of potential impacts and consultation status regarding NLEB.

Alternative D (Preferred Alternative) – Replacement of Both Highway Bridges with New Bridges - 4 Lanes and 2 Auxiliary Lanes

Estimated noise levels associated with construction and demolition activities will be calculated during Phase II of the project when specific construction methods, type of equipment, number of construction vehicles, duration of construction activities, hours of operation etc. have been identified. Mitigation measures will include complying with any conditions in construction permits or town ordinances. The project would have no effect on federally listed species, except for NLEB which may roost under the bridges. The USACE will consult with FWS pursuant to Section 7 of the Endangered Species Act (ESA) to determine if NLEB are present and identify measures necessary to minimize potential noise impacts to this species.

Underwater Anthropogenic (human made) Noise:

Underwater anthropogenic (human made) noise will likely be generated during some construction and demolition activities. Underwater anthropogenic (human-made) sounds, existing and predicted underwater noise levels, and their effect on aquatic species are addressed under EFH Section 6.4.3.

Alternative A – No Action

Routine bridge maintenance and emergency repairs would not involve any activities that would generate underwater noise levels. There would be no substantial acoustic impacts on aquatic species because all work would occur outside of the Canal. Therefore, there would be no anticipated impacts under the No Action Alternative.

Alternative B – Major Rehabilitation for Both Bridges

The use of construction barges in the Canal to support major rehabilitation may be necessary. Such barges are equipped with spuds that are driven into the sediment to stabilize the vessel. Specific details on the barges, the length of time they would be utilized, and the size and depth of the spuds will be defined in Phase II when the specific construction needs for major rehabilitation are established. In-water work or elevated noise levels in the water due to construction may have minimal temporary impacts on EFH species, and coordination would need to be undertaken with NMFS pursuant to the MSA.

Alternative D (Preferred Alternative) – Replacement of Both Highway Bridges with New Bridges - 4 Lanes and 2 Auxiliary Lanes

Underwater work related to the removal of existing bridge piers may affect EFH or fish species.

The USACE proposes to move the existing bridge piers from the water to the Canal shoreline, thus removing those structures as habitat. Replacement would also require in-water barges to hold support cranes. The needed dimensions of these barges are unclear at this time and will be defined in Phase II during consultation with NMFS. Preliminary estimates indicate barge-supported cranes would be required for approximately 8 months (two months for construction and two months for demolition for each bridge). However, the small size of the project area will not substantially affect the highly mobile EFH species or their habitat, and the Canal is expected to remain a highly productive ecosystem because of the connectivity with Cape Cod and Buzzards Bay. A construction supporting barge would not cause adverse shading on benthic communities due to the small size of this structure compared to the larger width and depth of the Canal. The exact dimensions of construction barges are dependent on specific project requirements, which are not yet known and will be defined in Phase II. The impact area associated with its spuds on prey resources and benthic habitat is also minimal, given the size and frequently dredged habitat of the Canal. Potential noise impacts from the project on fisheries and marine wildlife will be evaluated in Phase II of the project in consultation with NMFS, using their Technical Guidance for Assessing the Impacts of Anthropogenic Sound on Marine Mammal Hearing (Version 2.0).

In-water work or elevated noise levels in the water due to construction and demolition may have minimal temporary impacts on EFH species. The USACE will ensure these resources are considered through consultation with NMFS at the design and construction phase of this project pursuant to the MSA. Please reference the Threatened and Endangered Species (Section 6.4.4) and Essential Fish Habitat (Section 6.4.3) sections of this document for discussion on noise-related impacts and consultation.

6.7 Summary of Effects

EA Table 25 - Project Alternatives: Summary of Potential Effect, Coordination and Mitigation

Affected Environment/ Resource Area	**Alternative A - No Action**	**Alternative B - Major Rehabilitation**	**Alternative D - Preferred Alternative - Bridge Replacement with Auxiliary Lanes**	**Best Management Practices (BMPs)/Mitigation Measures to Be Applied**
Land Use	Negligible	Negligible	Minor	Mitigation for land use changes will be developed in Phase II when bridge designs are developed

Terrain and Topography	Negligible	Negligible	Minor	Standard construction industry BMPs
Geology/Soils	Negligible	Negligible	Negligible	Standard construction industry BMPs
Climate	Negligible	Negligible	Negligible	Required emissions controls and construction BMPs
Affected Environment/ Resource Area	**Alternative A - No Action**	**Alternative B - Major Rehabilitation**	**Alternative D - Preferred Alternative - Bridge Replacement with Auxiliary Lanes**	**Best Management Practices (BMPs)/Mitigation Measures to Be Applied**
Sea Level Change	Negligible	Negligible	Negligible	
Air Quality	Minor	Minor	Minor	Short-term, minor impacts to air quality are anticipated during the construction phase. Required emissions controls and construction BMPs
Water Quality	Negligible	Negligible	Negligible	Standard construction industry BMPs
Surface Water	Negligible	Negligible	Moderate	Standard construction industry BMPs

Affected Environment/ Resource Area	**Alternative A - No Action**	**Alternative B - Major Rehabilitation**	**Alternative D - Preferred Alternative - Bridge Replacement with Auxiliary Lanes**	**Best Management Practices (BMPs)/Mitigation Measures to Be Applied**
Wetlands	Negligible	Negligible	Moderate	Mitigation measures would be developed to address any wetland impacts Please refer to Section 6.2.1 for a discussion of wetland impacts
Groundwater	Negligible	Negligible	Negligible	Standard construction industry BMPs. Full evaluation of impacts will take place in Phase II.
Floodplain	Negligible	Negligible	Negligible	
Coastal Resources	Negligible	Negligible	Negligible	
Vegetation	Negligible	Negligible	Moderate	Construction BMPs will be developed when bridge designs are available

Wildlife	Negligible	Negligible	Minor	Measures to avoid, minimize, or mitigate wildlife impacts will be developed in Phase II in consultation with resource agencies. Please refer to Section 6.4 on Biological Resources for a discussion of wildlife impacts and agency consultation.
Affected Environment/ Resource Area	**Alternative A - No Action**	**Alternative B - Major Rehabilitation**	**Alternative D - Preferred Alternative - Bridge Replacement with Auxiliary Lanes**	**Best Management Practices (BMPs)/Mitigation Measures to Be Applied**
Fisheries	Negligible	Negligible	Minor	Measures to avoid, minimize, or mitigate fisheries impacts will be developed in Phase II in consultation with resource agencies. Please refer to section 6.4 on biological resources for a discussion of fisheries impacts.

Essential Fish Habitat	Negligible	Negligible	Minor	EFH consultation will occur in Phase II. Please refer to Section 6.4 on biological resources for a discussion of EFH impacts.
Affected Environment/ Resource Area	**Alternative A - No Action**	**Alternative B - Major Rehabilitation**	**Alternative D - Preferred Alternative - Bridge Replacement with Auxiliary Lanes**	**Best Management Practices (BMPs)/Mitigation Measures to Be Applied**
Threatened and Endangered Species	Negligible	Negligible	Minor	Consultation with the Services will determine BMPs and/or mitigation measures. Bat survey will occur prior to construction. Please see Section 6.4.4 for a discussion of T&E consultation status.
Historic and Cultural Resources	Negligible	Negligible	Moderate	Continued coordination with MA SHPO and tribes and development of a Memorandum of Agreement
Demographics	Minor	Minor	Minor	
Community Economics	Minor	Minor	Minor	
Water Quality	Negligible	Negligible	Negligible	

Recreation	Minor	Minor	Minor	
Public Utilities	Negligible	Minor	Moderate	
Public Health and Safety	Moderate	Moderate	Minor	
Affected Environment/ Resource Area	**Alternative A - No Action**	**Alternative B - Major Rehabilitation**	**Alternative D - Preferred Alternative - Bridge Replacement with Auxiliary Lanes**	**Best Management Practices (BMPs)/Mitigation Measures to Be Applied**
Hazardous Materials	Minor	Minor	Minor	Any hazardous materials/waste generated during construction will be handled and disposed of in accordance with all applicable Federal and State regulations and local ordinances
Noise	Negligible	Minor	Minor	Complying with conditions in construction permits or town ordinances to address short term increase in noise from construction and demolition activities
Traffic	Moderate	Moderate	Minor	
Environmental Justice	Negligible	Negligible	Negligible	

7.0 INDIRECT EFFECTS AND CUMULATIVE IMPACTS

CEQ's NEPA implementing regulations require federal agencies to consider the potential for indirect effects and cumulative impacts from a proposed project (40 CFR §1508.7, 1508.8). The MRER and accompanying EA evaluates the direct, indirect, and cumulative effects of major rehabilitation or replacement of the Bourne and Sagamore bridges over the Canal and to analyze alternatives to either repair or replace the existing bridges.

Indirect effects are defined as those that are caused by an action, and are later in time or farther removed in distance, but are still reasonably foreseeable. These effects can include inducing changes in patterns of land use, population density or growth rate as well as other related effects on air, water, and other natural ecosystems.

The National Cooperative Highway Research program identifies the following types of transportation projects that might result in indirect effects to a project area: construction of a new highway, highway extensions, bridges to currently undeveloped areas, new highway bypasses around congested downtowns, new or expanded airports and harbors, new rail transit, new interstate highways, or new interchanges in undeveloped or rural locations (NCHRP, 2002).

CEQ defines "cumulative impact" as the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or non-federal) or person undertakes such other actions." (40 C.F.R. § 1508.7). The assessment of cumulative effects in this EA addresses the potential impacts from the project and other projects proposed within, or in the vicinity of the Cape Cod Canal bridges study area.

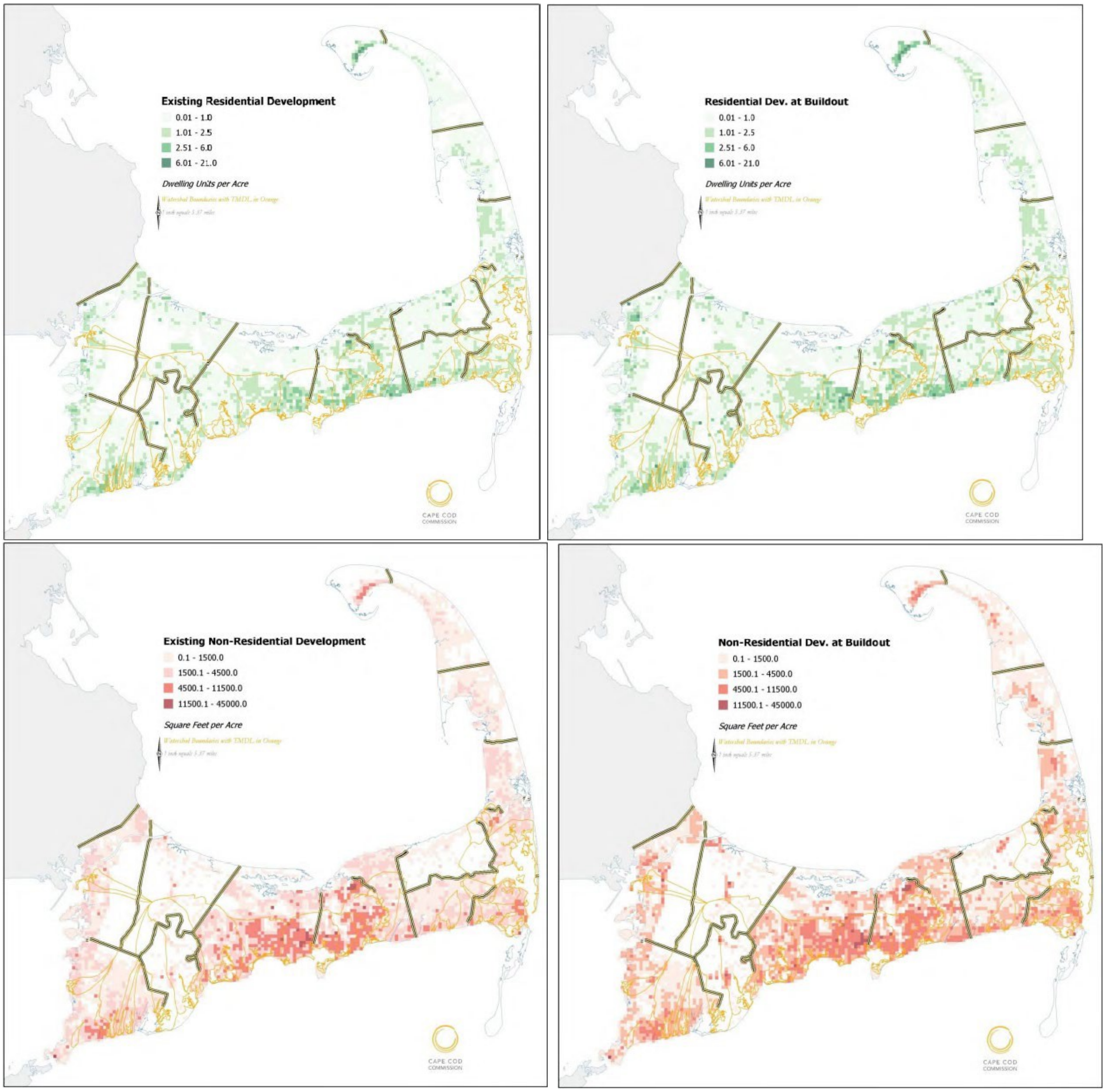
The Cape Cod Canal bridges have been in place since the 1930s. Past and present activities at the Cape Cod Canal include maintenance of the Federal navigation channel and routine maintenance of the Bourne and Sagamore bridges. Reasonably foreseeable future actions include the continuation of current maintenance and navigation activities as well as connected bridge approach road work required by MassDOT to connect new replacement bridges to existing roadways. MassDOT's conceptual projects described in their *Cape Cod Canal Transportation Study* (2019) and their potential for cumulative impacts to area resources will be discussed in the following sections.

7.1 Induced Development

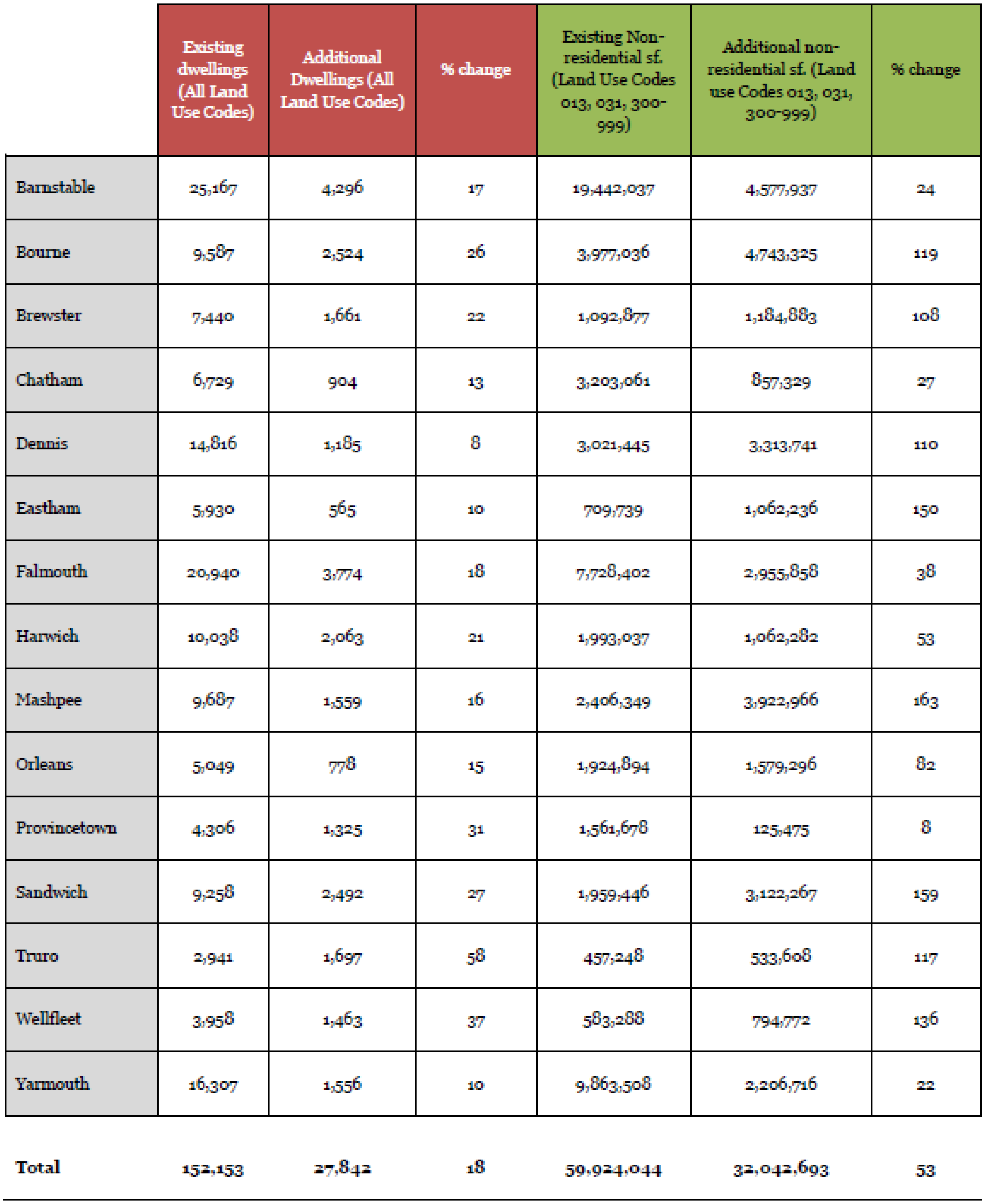
7.1.1 Development Potential

In 2012, the Cape Cod Commission completed a Cape-wide buildout analysis during development of a regional wastewater management plan for Cape Cod in order to quantify the growth potential in the region and determine the spatial distribution of this future growth. This study included a density analysis of existing and potential future development. The results (shown in the figures and table below) indicated that a total of 27,842 additional residential units (dwelling units/acre) and 32,042,693 square feet (s.f.) of additional non-residential area was available for development. In 2017, the University of Massachusetts Donahue Institute conducted a 10-year forecast as part of an independent market housing analysis and estimated potential future demand for an additional 26,000 residential units in Cape Cod. Therefore near capacity residential housing is expected without any bridge improvement projects.

EA Figure 23 - Cape Cod Residential and Nonresidential Development



EA Table 26 – Cape Cod Buildouts by Town



	Existing dwellings (All Land Use Codes)	Additional Dwellings (All Land Use Codes)	% change	Existing Non-residential sf. (Land Use Codes 013, 031, 300-999)	Additional non-residential sf. (Land use Codes 013, 031, 300-999)	% change
Barnstable	25,167	4,296	17	19,442,037	4,577,937	24
Bourne	9,587	2,524	26	3,977,036	4,743,325	119
Brewster	7,440	1,661	22	1,092,877	1,184,883	108
Chatham	6,729	904	13	3,203,061	857,329	27
Dennis	14,816	1,185	8	3,021,445	3,313,741	110
Eastham	5,930	565	10	709,739	1,062,236	150
Falmouth	20,940	3,774	18	7,728,402	2,955,858	38
Harwich	10,038	2,063	21	1,993,037	1,062,282	53
Mashpee	9,687	1,559	16	2,406,349	3,922,966	163
Orleans	5,049	778	15	1,924,894	1,579,296	82
Provincetown	4,306	1,325	31	1,561,678	125,475	8
Sandwich	9,258	2,492	27	1,959,446	3,122,267	159
Truro	2,941	1,697	58	457,248	533,608	117
Wellfleet	3,958	1,463	37	583,288	794,772	136
Yarmouth	16,307	1,556	10	9,863,508	2,206,716	22
Total	**152,153**	**27,842**	**18**	**59,924,044**	**32,042,693**	**53**

Source: Cape Cod Commission

In a recent Cape Cod Commission Memorandum to the USACE the Commission explained that they are a regional land use planning and regulatory agency created by the state legislature in 1990 and that through their regulatory program, the Commission reviews projects that present regional issues identified in the Act as Developments of Regional Impact (DRI). The Commission's regulatory review supplements local authority throughout the 15 towns of Barnstable County. Towns refer projects to the Commission for DRI review to seek Commission consideration of specific project-related impacts. Similar to other municipalities in Massachusetts, development on Cape Cod is also subject to local zoning and other regulations or town bylaws that control buildout/development on the Cape, as well as areas regulated at the state or regional level where growth may be limited (April, 2019).

As there is existing Cape Cod Commission review of proposed development projects, as well as zoning regulations or other town bylaws in place that control build out/development on the Cape, bridge rehabilitation or replacement will not affect any future development.

7.1.2 Traffic modeling

Current traffic model outputs show the current (2014) and future (2040) average speed over 13 segments of road with the existing two-lane bridges and with new two-lane bridges with an auxiliary acceleration/deceleration lane that accommodates on/off ramps (EA Table 27)[4]. The traffic model only shows a difference in average travel time over the new versus existing bridges during the weekend summer mid-day time period (change in speed spreadsheet). An increase in speed of 2 miles per hour decreases the average travel time over the average route length by less than 20 seconds[5] (note, potential road improvements made by MassDOT are not included in this analysis). This change in accessibility would translate to no or weak potential for land use change according to the matrix provided by the Oregon Department of Transportation.

It is important to note that this analysis does not include any proposed changes to road infrastructure by MassDOT. The Sagamore and Bourne bridges are not the only source of bottleneck traffic. The current network of roads around the bridges and throughout the Cape limit ease of traffic flow. Replacement bridges will not have a significant impact on alleviating traffic problems without improvements of roadways throughout the Cape.

---

[4] Note that these changes do not take new approaches into account. This traffic model does not incorporate land use change projections, or potential changes in travel demand, but it does incorporate future population projections.

[5] 32 miles/hr X 1/60 hr/min=0.53 miles/min

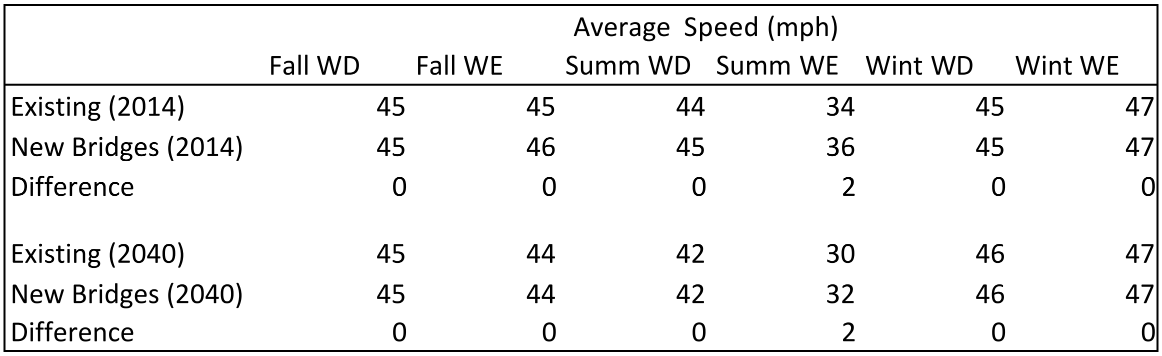
2.74 miles X 1/0.53 min/mile = 5.17 min

30 miles/hr X 1/60 hr/min=0.5 miles/min

2.74 miles X 1/0.5 min/mile = 5.48 min

5.48-5.17=.31 (so < 1/3 of a minute

EA Table 27 - Average speed over 13 segments of road with existing and new bridges during weekdays (WD) and weekends (WE) in fall, summer and winter seasons



	Average Speed (mph)					
	Fall WD	Fall WE	Summ WD	Summ WE	Wint WD	Wint WE
Existing (2014)	45	45	44	34	45	47
New Bridges (2014)	45	46	45	36	45	47
Difference	0	0	0	2	0	0
Existing (2040)	45	44	42	30	46	47
New Bridges (2040)	45	44	42	32	46	47
Difference	0	0	0	2	0	0

*Notes: The average length of routes analyzed is 2.74 miles.

Even if there are substantial reductions in travel time due to improvements to the bridges, it may not improve accessibility once on the Cape. A Cape Cod Metropolitan Planning Organization report (CCMPO, 2015) shows that there has been consistent growth in traffic throughout the Cape. Because roads throughout Cape Cod "are restricted in route options, profile, and capacity" (Commonwealth of Massachusetts 2016, p. 3) and "taxed or failing at present" (p 81, The Chesapeake Group, 2013) there are problems managing current traffic conditions throughout the Cape. The Regional Transportation Plan Survey, conducted in 2015, asked respondents to identify problem locations for transportation on the Cape (CCMPO, 2015). The below figure shows that survey respondents identified congestion issues throughout the Cape, not just along the canal. In addition, a Cape Cod Regional Transportation Plan (compiled by the Cape Cod Commission and voted on by the Cape Cod Metropolitan Planning Organization), identifies improvements to Route 28 in Hyannis as one of its highest priorities. Traffic congestion improvements resulting from bridge replacement will not resolve the traffic issues associated with the limited capacity of the current road system. Because bridge replacement will not address traffic and congestion issues on the Cape's interior roadways, visitors will still encounter high traffic volume on the Cape. Therefore, it is not likely that bridge replacement will substantially improve access to the Cape and subsequently increase the number of visitors and associated development.[6]

---

[6] Many residents feel that there is already too much congestion and development, and do not want to further develop road infrastructure to limit development on the Cape (Cape Cod Business Climate Survey page 15 of pdf)

EA Figure 24 - Traffic Congestion Areas on the Cape

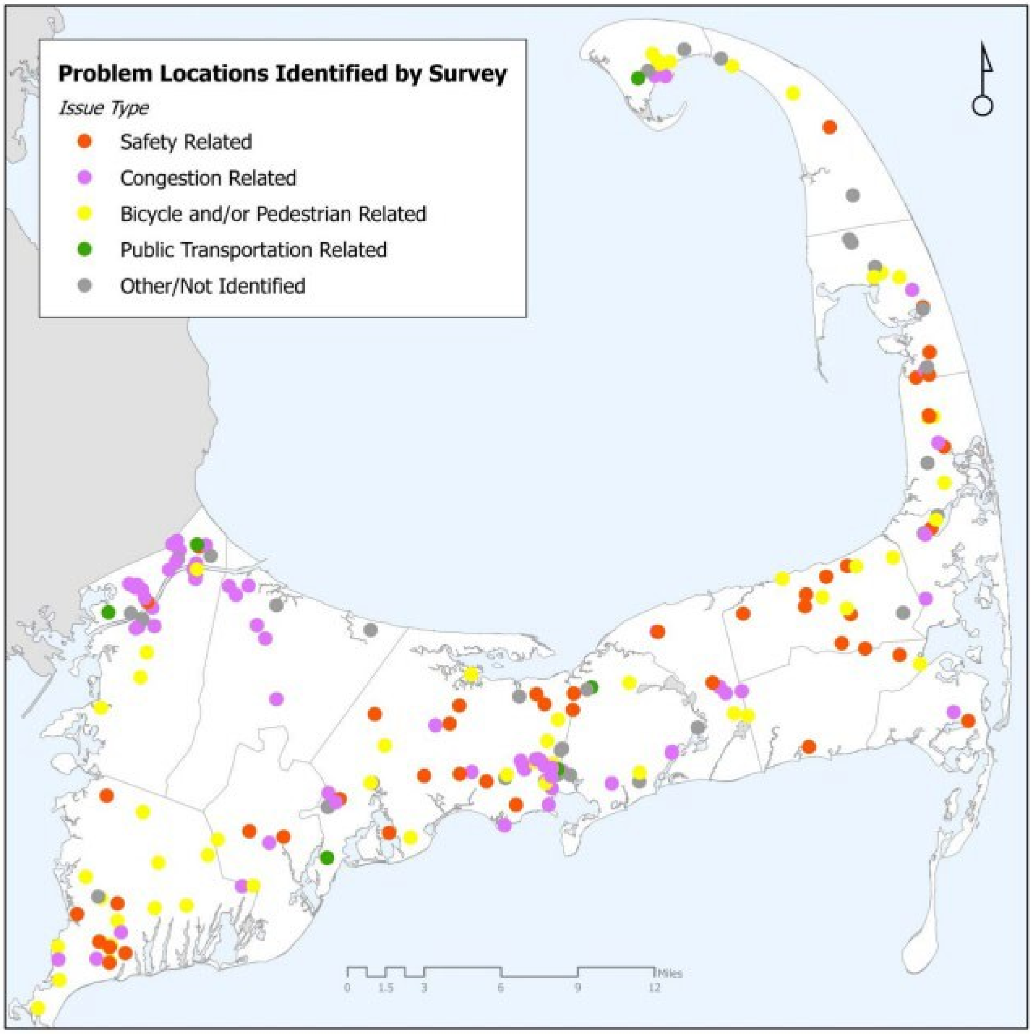

Problem Locations Identified by Survey
Issue Type
Safety Related
Congestion Related
Bicycle and/or Pedestrian Related
Public Transportation Related
Other/Not Identified
0
1.5
3
6
9
12
Miles

FIGURE 4. RTP SURVEY RESULTS - PROBLEM LOCATIONS IDENTIFIED

From: The Cape Cod Regional Transportation Plan (CCMPO 2015)

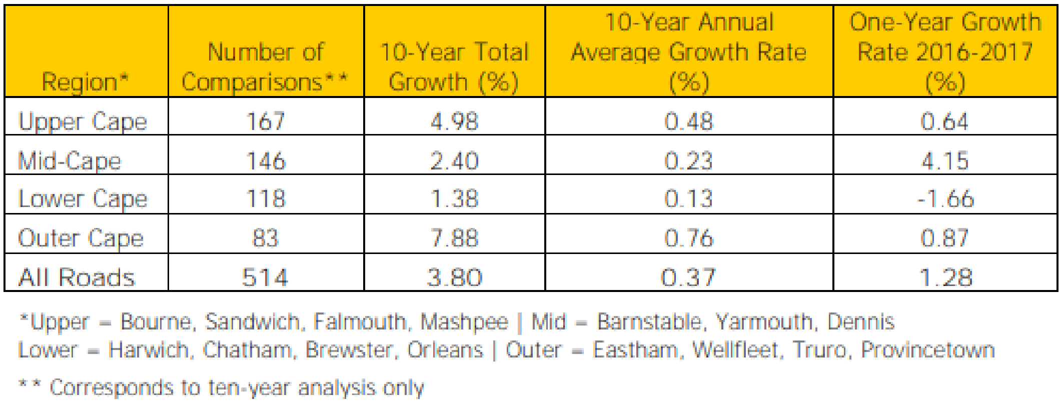
7.1.3 Population models and forecasted growth

Since 2000, population growth slightly decreased in Barnstable County (US Census). These population dynamics are largely attributed to a large influx of baby boomers retiring to the region, the subsequent increase in death rates due to an ageing population, and younger populations leaving the region to pursue employment and educational opportunities (Cape Cod Commission 2017, Renski et al. 2015). Retail, recreation, accommodation and food services make up more than 25% of Barnstable County's employment compared with less than 20% of employment across MA (Bureau of Labor Statistics). Employment is also highly seasonal.

Employment opportunities are relatively limited on the Cape, in addition, housing and the cost of living is higher.

The 2010 US Census reports 215,888 individuals living in Barnstable County (222,230 in 2000). While some projections estimate an overall reduction in population on Cape Cod (Renski et al. 2015), others estimate an increase in population. Moody's analytics (2016) projects that economic growth in the area (unrelated to the bridge improvements) will stimulate in-migration resulting in an increase of 9,612 people to Barnstable County between 2015 and 2025; Crane Associates similarly projects a more conservative increase in population of 6,199 people (Crane Associates Team, 2017). Even using the more conservative increase in population, the total population change is less than 5% over the ten year period. According to the ECONorthwest & Portland State University matrix (2001), an average annual growth rate of less than 1% per year is considered to have little to no potential for land use change in the study area.

EA Table 28 - Cape Cod Summer Traffic Growth by Subregion



Region*	Number of Comparisons**	10-Year Total Growth (%)	10-Year Annual Average Growth Rate (%)	One-Year Growth Rate 2016-2017 (%)
Upper Cape	167	4.98	0.48	0.64
Mid-Cape	146	2.40	0.23	4.15
Lower Cape	118	1.38	0.13	-1.66
Outer Cape	83	7.88	0.76	0.87
All Roads	514	3.80	0.37	1.28

*Upper = Bourne, Sandwich, Falmouth, Mashpee | Mid = Barnstable, Yarmouth, Dennis
Lower = Harwich, Chatham, Brewster, Orleans | Outer = Eastham, Wellfleet, Truro, Provincetown

** Corresponds to ten-year analysis only

The bridge rehabilitation or replacement projects are not expected to lead to significant induced development and will not result in localized or regional indirect effects for the following reasons:

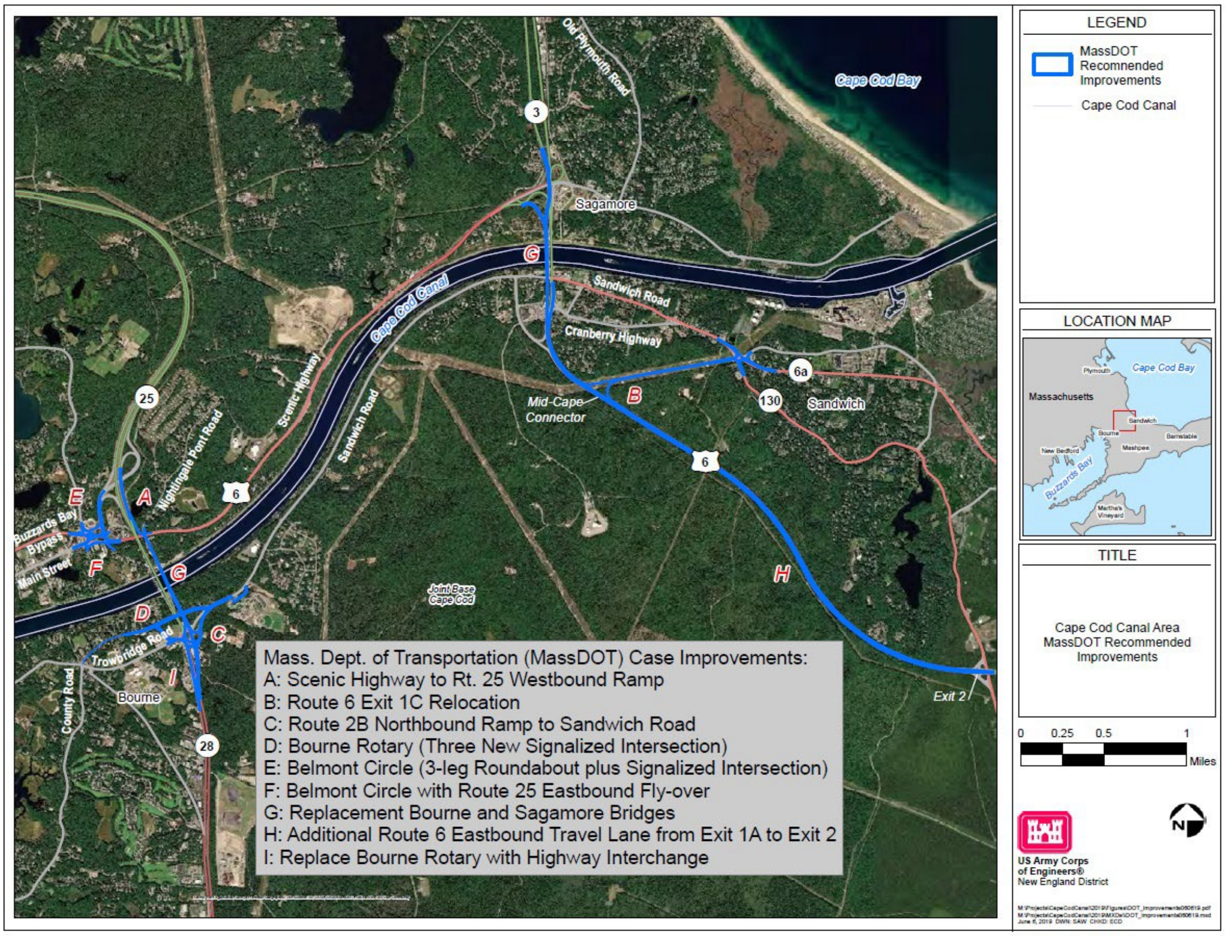
- There is not a lot of available developable land and with expected growth already anticipated without bridge projects, the available developable land will be even more limited. Near capacity residential housing is already expected without improved bridges and therefore further opportunities for development are limited.
- Employment opportunities are limited, and housing is relatively expensive compared to the state average, therefore younger populations tend to move off-Cape. Even with improved bridges the Cape's population dynamics would not change.
- The availability of seasonal and vacation housing (e.g. hotels) has a greater effect on the number of people visiting the Cape than any access limitations created by the Sagamore and Bourne bridges.
- The existing road infrastructure on the Cape has numerous transportation bottlenecks that would limit the effects of bridge replacement on future growth and development.

7.2 Cumulative Impacts

The MA Department of Transportation (MassDOT) completed a *Cape Cod Canal Transportation Study* in May 2019. The purpose of this regional "conceptual planning study" was to "evaluate existing and future transportation safety and congestion deficiencies in the Cape Cod Canal Study Area" and included the development and analysis of the following multimodal transportation alternatives (EA Figure 25):

(1) Scenic Highway to Rte. 25 Westbound On-Ramp
(2) Rte. 6 Exit 1C Relocation
(3) Rte. 28 Northbound Ramp to Sandwich Road
(4) Bourne Rotary (Three New Signalized Intersections)
(5) Belmont Circle (3 Leg Roundabout plus Signalized Intersection)
(6) Belmont Circle with Rte. 25 Eastbound Fly-over
(7) Replacement Bridges (Bourne and Sagamore) – 2 travel lanes with auxiliary lane in each direction
(8) Additional Rte. Eastbound Travel lane from Exit 1A to Exit 2 (3 total lanes)
(9) Bourne Rotary with Highway Interchange

EA Figure 25 - MassDOT Conceptual Improvement Projects


Mass. Dept. of Transportation (MassDOT) Case Improvements:
A: Scenic Highway to Rt. 25 Westbound Ramp
B: Route 6 Exit 1C Relocation
C: Route 2B Northbound Ramp to Sandwich Road
D: Bourne Rotary (Three New Signalized Intersection)
E: Belmont Circle (3-leg Roundabout plus Signalized Intersection)
F: Belmont Circle with Route 25 Eastbound Fly-over
G: Replacement Bourne and Sagamore Bridges
H: Additional Route 6 Eastbound Travel Lane from Exit 1A to Exit 2
I: Replace Bourne Rotary with Highway Interchange
LEGEND
MassDOT Recommended Improvements
Cape Cod Canal
LOCATION MAP
Plymouth
Cape Cod Bay
Massachusetts
Sandwich
Bourne
Barnstable
New Bedford
Mashpee
Buzzards Bay
Martha's Vineyard
TITLE
Cape Cod Canal Area MassDOT Recommended Improvements
0
0.25
0.5
1
Miles
N
US Army Corps of Engineers®
New England District
Cape Cod Bay
Old Plymouth Road
3
Sagamore
Cape Cod Canal
Sandwich Road
Cranberry Highway
Scenic Highway
Sandwich Road
Mid-Cape Connector
6a
130
Sandwich
6
25
Nightingale Pond Road
Buzzards Bay Bypass
Main Street
Joint Base Cape Cod
Trowbridge Road
County Road
Bourne
28
Exit 2
A
B
C
D
E
F
G
H
I

The MassDOT Alternatives are based on the assumption that the USACE will replace both the Bourne and Sagamore bridges. The section below examines only those conceptual MassDOT projects that could potentially be linked to the replacement of the Bourne and Sagamore bridges. MassDOT alternatives descriptions text below is taken from the Cape Cod Canal Transportation Study (2019) and is supplemented with USACE GIS analysis. A summary of potential impacts table is provided for each of these alternatives.

7.2.1 Bourne Rotary Alternatives

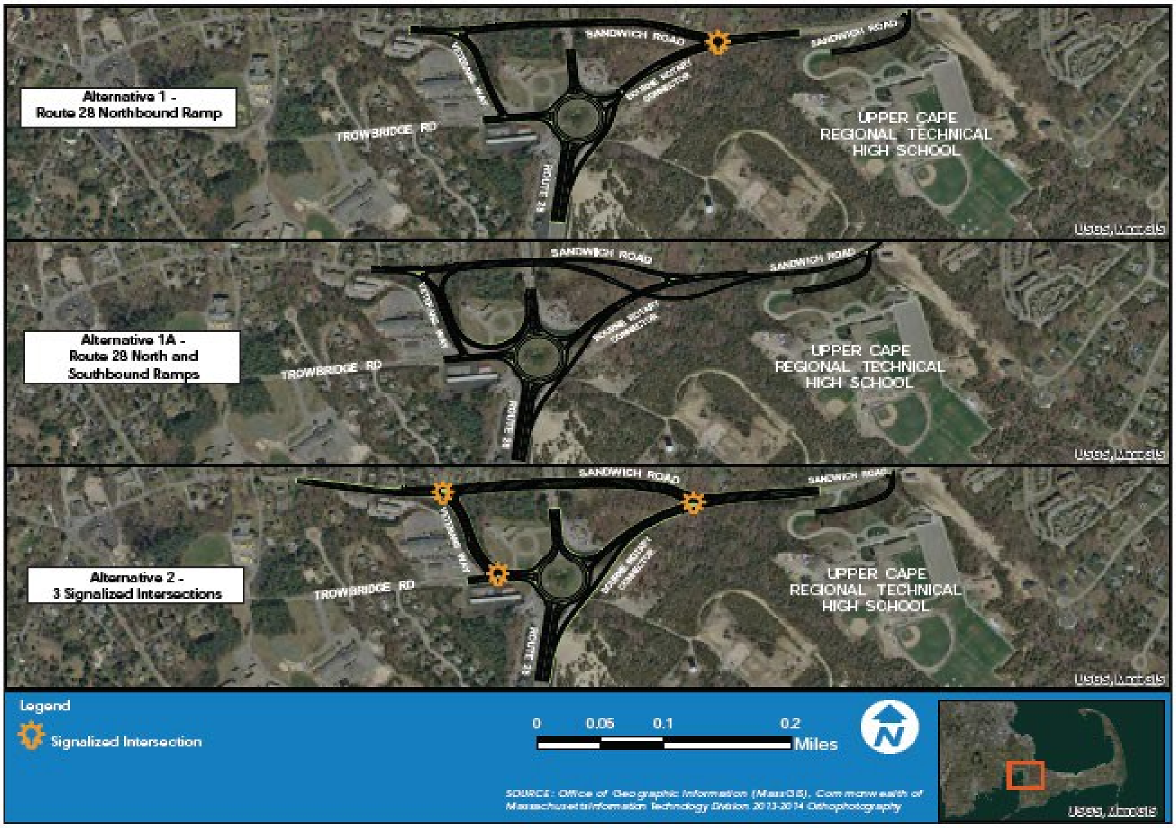
The Bourne Rotary is immediately south of the Bourne Bridge. The roadway approaches to the Bourne Rotary include Route 28 (on both the north and south sides of the Rotary), Trowbridge Road, and the Bourne Rotary Connector. Sandwich Road provides a roadway connection north of the rotary between Trowbridge Road (via Veterans Way) and the Bourne Rotary Connector. MADOT evaluated several alternatives to improve traffic operations at the Bourne Rotary. They include Route 28 Northbound Ramp (1); Route 28 Northbound and Southbound Ramp with

Sandwich Road Underpass (1A); and Three Signalized Intersections (2) (EA Figure 26, below). These alternatives were conceived to be compatible with the existing Bourne Bridge as well as with the vertical and horizontal alignment of an assumed replacement of the Bourne Bridge. Each of these alternatives assumes that the local intersection improvements at the Sandwich Road at the Bourne Rotary Connector are completed.

As shown on EA Table 29, none of the three alternatives evaluated for the reconstruction of the Bourne Rotary would impact wetland resources, 100-year floodplain, or rare species habitat. Alternative 1A would require the acquisition of approximately one acre of land from the Town of Bourne. All alternatives may require minor property acquisitions from the USACE and adjacent residential and commercial properties.

The Route 28 ramp may require a minor property acquisition from the Massachusetts State Police barracks.

EA Figure 26 - MassDOT Alternatives Evaluated – Bourne Rotary


Alternative 1 -
Route 28 Northbound Ramp
Alternative 1A -
Route 28 North and Southbound Ramps
Alternative 2 -
3 Signalized Intersections
SANDWICH ROAD
TROWBRIDGE RD
ROUTE 28
BOURNE ROTARY CONNECTOR
UPPER CAPE REGIONAL TECHNICAL HIGH SCHOOL
Legend
Signalized Intersection
0
0.05
0.1
0.2
Miles
N
SOURCE: Office of Geographic Information (MassGIS), Commonwealth of Massachusetts Information Technology Division 2013-2014 Orthophotography
USGS, MassGIS

EA Table 29 - Bourne Rotary - Environmental Impact by Alternative

	Alternative 1	Alternative 1A	Alternative 2
Resource Area (ac):			
NHESP Rare Species Habitat	0	0	0
NWI Wetlands	0	0	0
100-year Floodplain	0	0	0
IWPA (Interim Wellhead Protection Area)	0	0	0

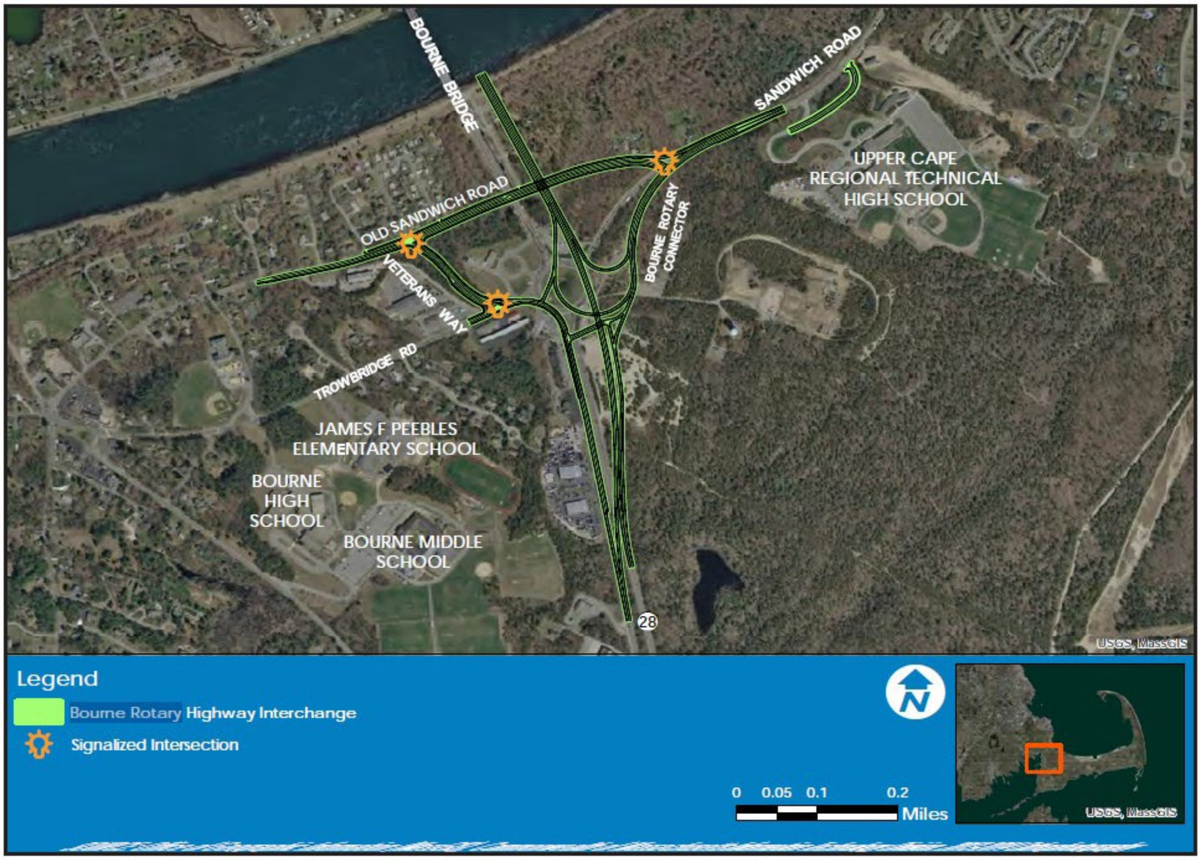
7.2.2 Bourne Rotary with Highway Interchange

A larger-scale alternative to improve traffic operations at the Bourne Rotary was evaluated. This alternative involves the reconstruction of the Bourne Rotary as a highway interchange (EA Figure 27). This alternative assumes the prior intersection improvements at Bourne Rotary (Alternative 2 – Three Signalized Intersections – discussed above) are already in place. This alternative was conceived to be constructed concurrent with an assumed replacement of the Bourne Bridge, with an alignment immediately east of the existing bridge.

The reconstruction of the Bourne Rotary as a highway interchange intersection involves the removal of the Rotary and the construction of a grade-separated highway ramp system allowing vehicles to enter Route 28 (northbound or southbound) directly from Sandwich Road (via the Bourne Rotary Connector) or Trowbridge Road. Local traffic would pass directly over Route 28 on an overpass. The grade-separated interchange would remove the numerous conflict points that currently exist at the Rotary, substantially reducing queuing and crash rates.

As shown on EA Table 30, the Bourne Rotary Interchange alternative would not impact wetland resources, 100-year floodplains or land owned by the Town of Bourne. This alternative may impact a minor amount of rare species habitat (0.2 acres). The interchange alternative would require the acquisition of approximately 0.4 acres of land from the USACE and 0.3 acres of residential property. The interchange would also require approximately 2.2 acres of commercial land east of the Rotary.

EA Figure 27 - MassDOT Bourne Rotary Interchange



EA Table 30 - Bourne Rotary with Highway Interchange - Environmental Impact

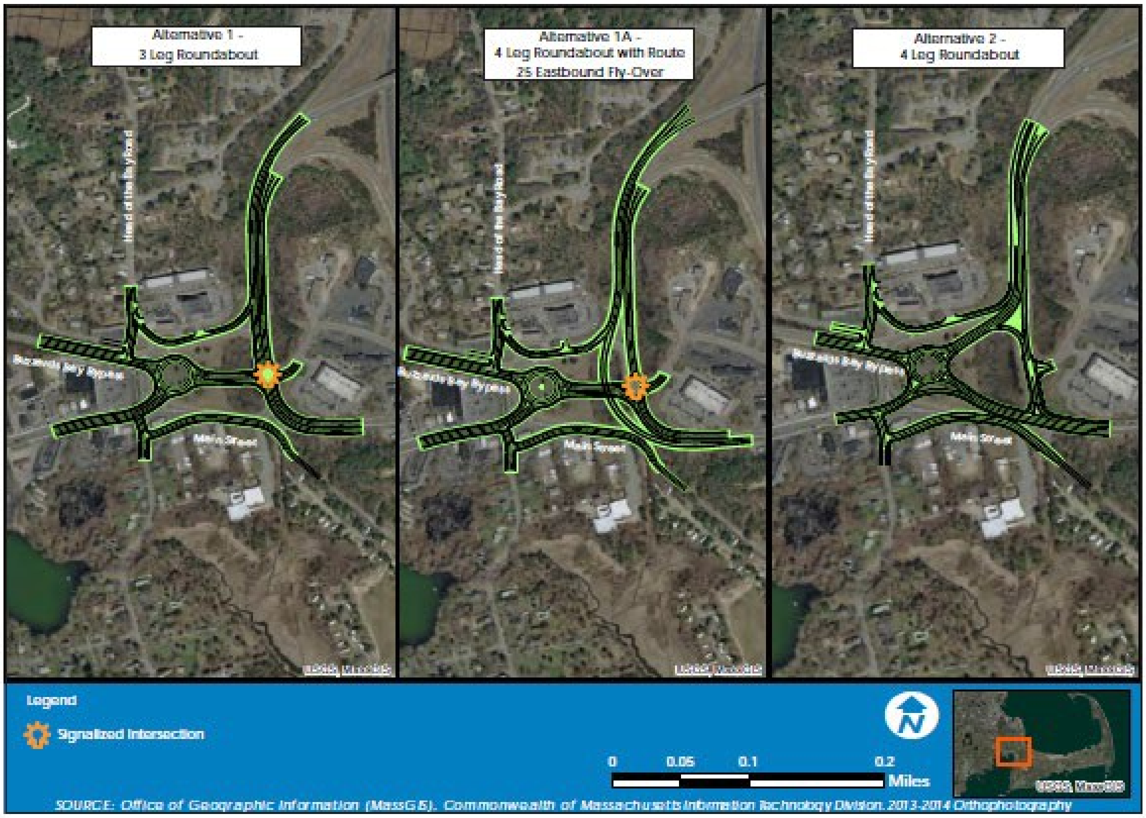
	Alternative 1
Resource Area (ac):	
NHESP Rare Species Habitat	0.2
NWI Wetlands	0
100-year Floodplain	0
IWPA (Interim Wellhead Protection Area)	0

7.2.3 Belmont Circle

Belmont Circle is the intersection of Route 25, Main Street, Scenic Highway, and the Buzzards Bay Bypass. Bourne Rotary processes vehicles from Route 28, Sandwich Road, and Trowbridge Road. Several alternatives were evaluated to improve traffic operations at Belmont Circle. All include the new Entrance Ramp, Scenic Highway Westbound to Route 25 Westbound project. Alternatives include: Three-Leg Roundabout with Signalized Intersection (1), Three-Leg Roundabout with Signalized Intersection and Flyover Ramp (1A), and Four-Leg Roundabout (2)(EA Figure 28, below).

A Route 25 westbound entrance ramp from Scenic Highway would result in approximately 0.2 acres of impact to land within an interim wellhead protection area. No wetland, floodplain, or rare species habitat areas would be impacted (EA Table 31). This ramp would be partially within an area containing natural gas lines, requiring close coordination with the utility company to determine if relocation of these gas lines would be necessary. Each of the three alternatives for the reconstruction of Belmont Circle would impact wetland resources and 100-year floodplain, as shown in EA Figure 28. Open space and residential and commercial property acquisitions may also be required.

EA Figure 28 – MassDOT Alternatives Evaluated – Belmont Circle



SOURCE: Office of Geographic Information (MassGIS). Commonwealth of Massachusetts Information Technology Division. 2013-2014 Orthophotography

EA Table 31 - Belmont Circle Reconstruction - Environmental Impact by Alternative

	Scenic Hwy to Rte. 25 WB Ramp	Alternative 1	Alternative 1A	Alternative 2
Resource Area (ac):				
NHESP Rare Species Habitat	0	0	0	0
NWI Wetlands	0	0.4	0.7	0.1
100-year Floodplain	0	4.7	5.4	4.6
IWPA (Interim Wellhead Protection Area)	0.2	0.5	0.5	0.4

7.2.4 Route 6 Exit 1C Relocation

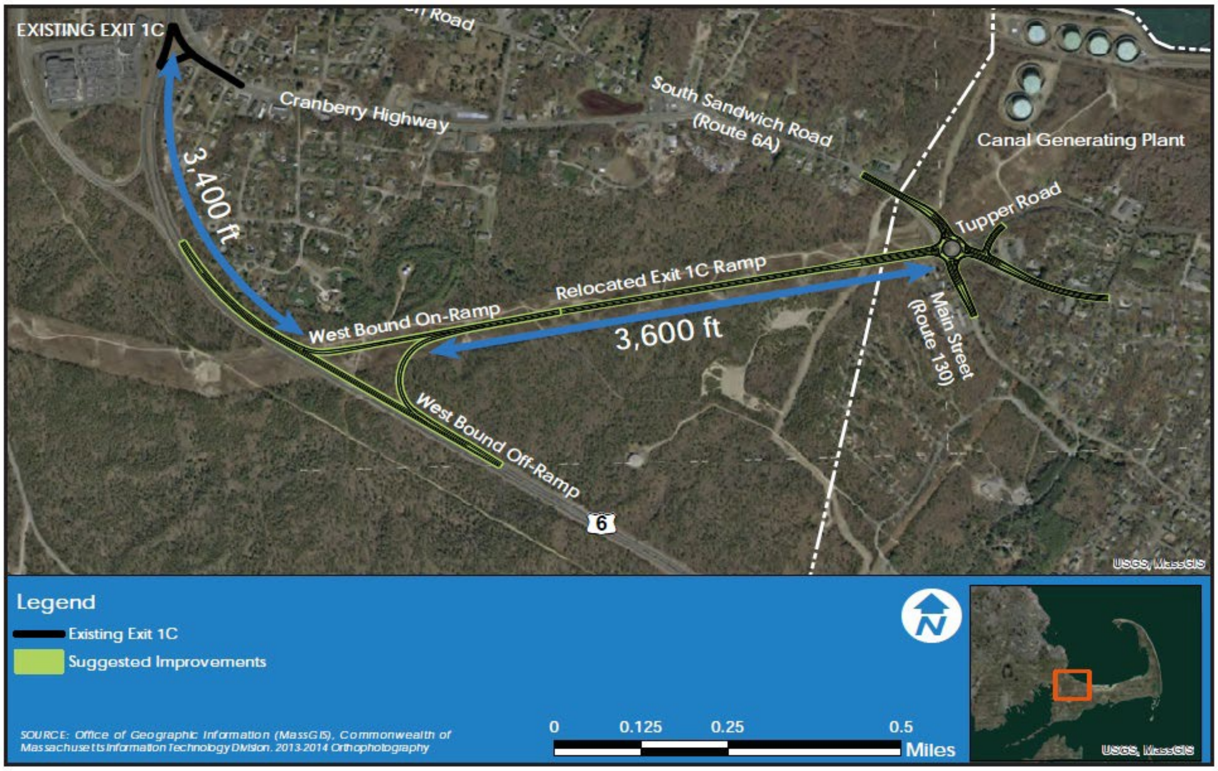
Route 6 at Exit 1C (at Cranberry Highway) provides an exit and entrance on Route 6 for westbound vehicles only (EA Figure 28). Exit 1C is the last westbound interchange on Route 6 prior to crossing the Cape Cod Canal on the Sagamore Bridge. The geometry of Exit 1C is substandard and not in compliance with current MassDOT highway design standards. The deficiencies of Exit 1C include short acceleration and deceleration lanes, and steep grades approaching the Sagamore Bridge.

The following presents the evaluation of the relocation of Route 6 Exit 1C from its existing location at the base of the south end of the Sagamore Bridge to a point further east on Route 6.

Land uses around Exit 1C include residential properties east of Route 6 and a retail shopping plaza (including a Market Basket grocery store) on the west side of Route 6. Land uses along Cranberry Highway include the Christmas Tree Shops retail store, and mix of residential, retail, restaurant, and auto-related shops. Further east, Joint Base Cape Cod abuts the west side of Route 6 from the Mid-Cape Connector interchange to Exit 2. Land use east of Route 6 includes residential neighborhoods and the Shawme-Crowell State Forest (which extends nearly to Exit 2). An electrical utility corridor divides the state forest and extends 3,600 feet from Route 6 to the Route 6A at Route 130 intersection, continuing northeast approximately 3,300 feet to the Canal Electrical Generating Plant.

No wetland, floodplain, or other regulated water resources would be impacted by the Route 6 Exit 1C Relocation. The land within JBCC, the Shawme Crowell State Forest, and the utility corridor is designated by the Massachusetts Natural Heritage and Endangered Species Program as a ‘Priority Habitat for Rare Species’ (EA Figure 29). These improvements would impact approximately 7.2 acres of land designated as a ‘Priority Habitat for Rare Species’. The federally-listed species known to occur in the study area include the piping plover, roseate tern, and red knot (all bird species), the red bellied cooter turtle, the sandplain gerardia (flower), the northeastern red tiger beetle, and the northern long-eared bat.

EA Figure 29 - MassDOT Route 6 Exit 1C Relocation



SOURCE: Office of Geographic Information (MassGIS), Commonwealth of Massachusetts Information Technology Division. 2013-2014 Orthophotography

EA Table 32 - Route 6 Exit 1C Relocation - Environmental Impact

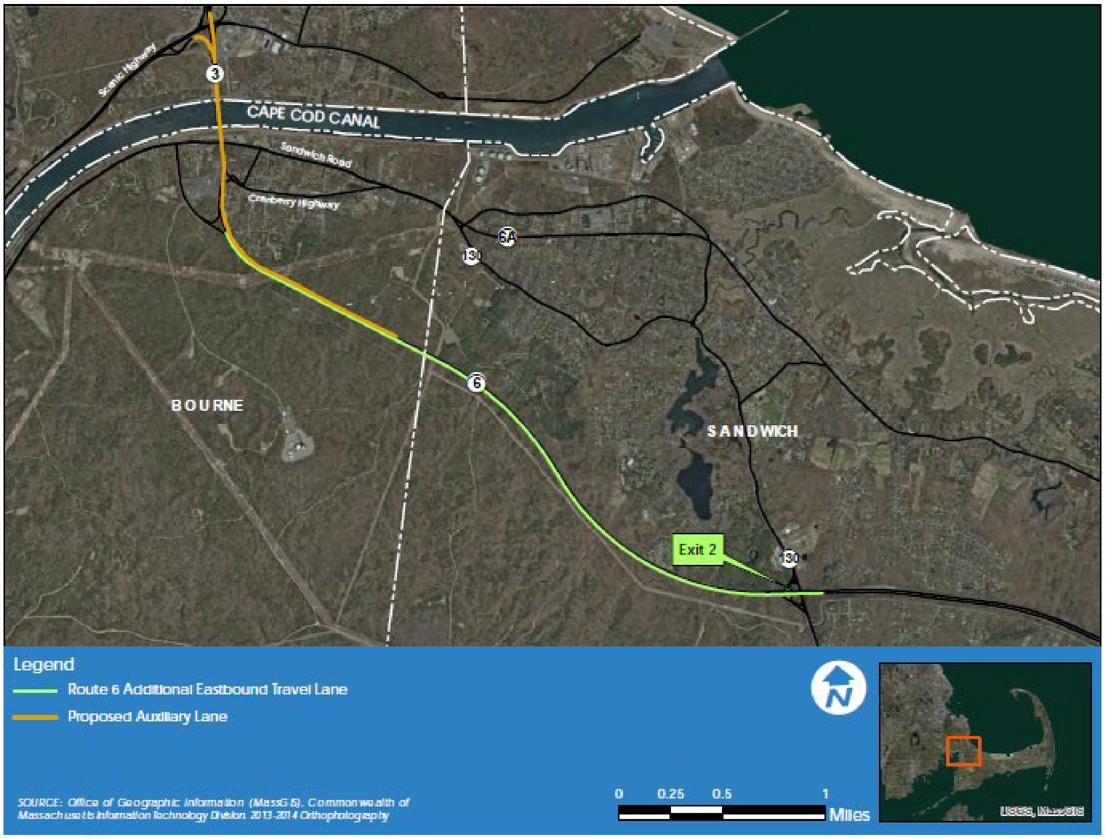
	Alternative 1
Resource Area (ac):	
NHESP Rare Species Habitat	7.2
NWI Wetlands	0
100-year Floodplain	0
IWPA (Interim Wellhead Protection Area)	0

7.2.5 Route 6 Additional Eastbound Travel Lane

Land uses in the area include approximately 100 residential properties east of Route 6, with access to Cranberry Highway at Exit 1C (EA Figure 30). Other than a utility corridor and a small residential development south of Shawme Lake, land uses adjacent to Route 6 for the remainder of the corridor consist of undeveloped forest within Joint Base Cape Cod west of Route 6 and the Shawme-Crowell State Forest east of Route 6.

There are no wetlands, floodplains, or other regulated wetland resources within 100 feet of the Route 6 corridor. The forested land within Joint Base Cape Cod and the Shawme-Crowell State Forest is designated by the Massachusetts Natural Heritage and Endangered Species Program as a ‘Priority Habitat for Rare Species’. The work may impact up to 3.9 acres of rare species habitat. No other regulated environmental resources, such as wetlands or floodplains, would be impacted. These improvements could be constructed entirely within the MassDOT right-of-way, with no property acquisitions required.

EA Figure 30 - MassDOT Route 6 – Additional Eastbound Travel Lane and Westbound Auxiliary Lane



SOURCE: Office of Geographic Information (MassGIS), Commonwealth of Massachusetts Information Technology Division. 2013-2014 Orthophotography

EA Table 33 - Route 6 Additional Eastbound Travel Lane - Environmental Impact

	Alternative 1
Resource Area (ac):	
NHESP Rare Species Habitat	3.9
NWI Wetlands	0
100-year Floodplain	0
IWPA (Interim Wellhead Protection Area)	0

7.2.6 Total Cumulative Impacts

If implemented, the MassDOT options outlined above using Alternative 1 scenarios only would have 4.7 acres of impact to the 100-year floodplain, 0.4 acres of impact to NWI Wetlands, 11.3 acres of impact to NHESP Rare Species Habitat, and 0.7 acres of impact to Interim Wellhead Protection Areas (IWPA). Impacts would primarily result due to Belmont Circle reconstruction and the Route 6 Additional Eastbound Travel Lane. For similar reasons described in the section above concerning induced development, these improvements are not anticipated to substantially affect the potential for induced development on Cape Cod.

EA Table 34 - Total Cumulative Impacts for MassDOT Projects with Alternative 1 Scenarios

	Alternative 1
Resource Area (ac):	
NHESP Rare Species Habitat	11.3
NWI Wetlands	0.4
100-year Floodplain	4.7
IWPA (Interim Wellhead Protection Area)	0.7

7.3 Cumulative Significance:

While the MassDOT final report includes recommended plans for transportation improvements, these are in concept only. No plans have been identified for implementation and no funding or authorization has been obtained. Future MassDOT Cape Cod transportation improvement projects are uncertain at this phase and if identified in the future further analysis will be conducted during the anticipated Supplemental EA.

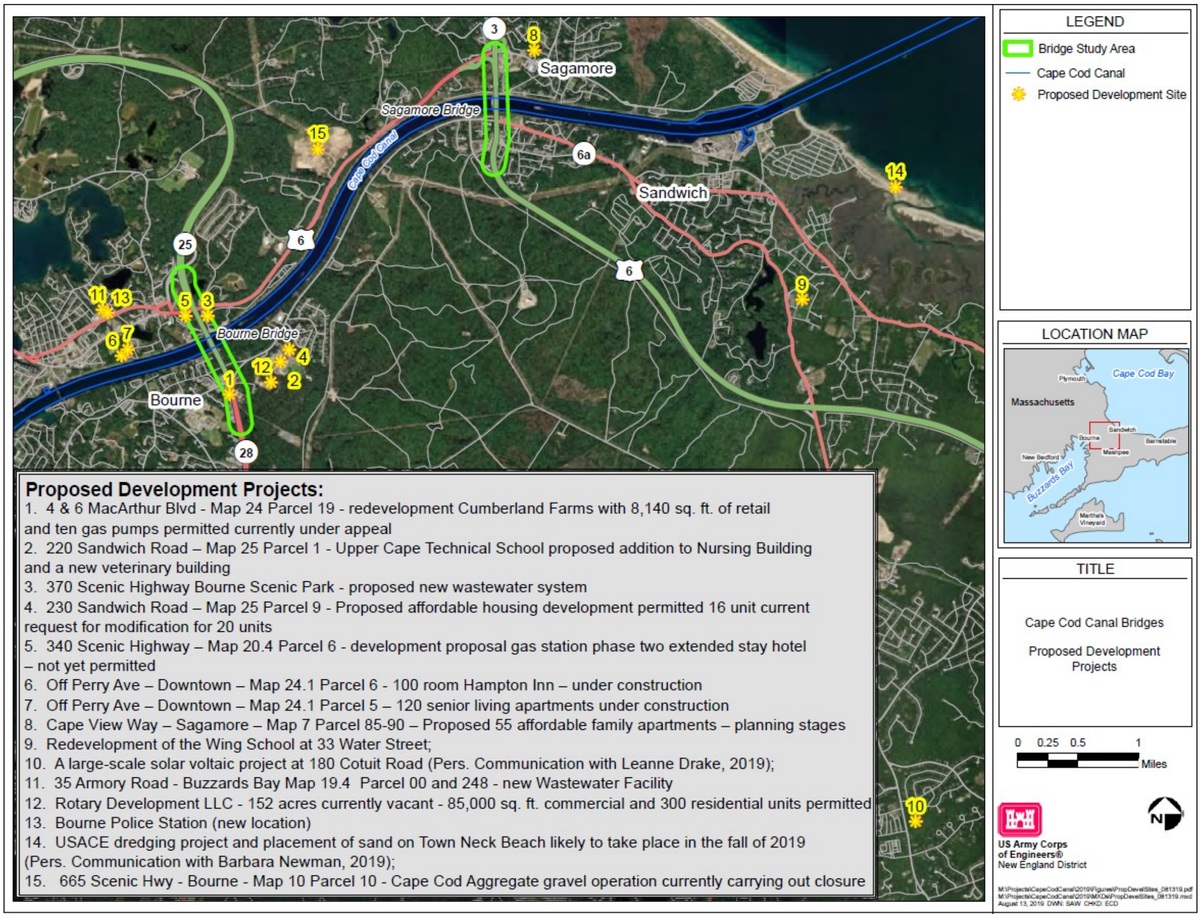
7.4 Other Development Projects:

The USACE contacted the local Conservation Commissions and Planning Boards in the towns of Bourne and Sandwich, MA to identify any current or planned future projects in each community as well as their proximity to the bridges study area. Fifteen projects were identified (EA Figure 31).

Although three projects fall within the study area: redevelopment of Cumberland Farms, a proposed new wastewater system, and a gas station and extended stay hotel, all are located in previously developed areas and present no cumulative environmental impacts.

All potential projects will be further evaluated during the design and construction phase (Phase II) of the project. There will be no significant cumulative environmental impacts from major rehabilitation or replacement of the Bourne and Sagamore bridges in association with any of the other proposed development projects listed.

EA Figure 31 - Proposed Development Projects



Proposed Development Projects:

1. 4 & 6 MacArthur Blvd - Map 24 Parcel 19 - redevelopment Cumberland Farms with 8,140 sq. ft. of retail and ten gas pumps permitted currently under appeal
2. 220 Sandwich Road – Map 25 Parcel 1 - Upper Cape Technical School proposed addition to Nursing Building and a new veterinary building
3. 370 Scenic Highway Bourne Scenic Park - proposed new wastewater system
4. 230 Sandwich Road – Map 25 Parcel 9 - Proposed affordable housing development permitted 16 unit current request for modification for 20 units
5. 340 Scenic Highway – Map 20.4 Parcel 6 - development proposal gas station phase two extended stay hotel – not yet permitted
6. Off Perry Ave – Downtown – Map 24.1 Parcel 6 - 100 room Hampton Inn – under construction
7. Off Perry Ave – Downtown – Map 24.1 Parcel 5 – 120 senior living apartments under construction
8. Cape View Way – Sagamore – Map 7 Parcel 85-90 – Proposed 55 affordable family apartments – planning stages
9. Redevelopment of the Wing School at 33 Water Street;
10. A large-scale solar voltaic project at 180 Cotuit Road (Pers. Communication with Leanne Drake, 2019);
11. 35 Armory Road - Buzzards Bay Map 19.4 Parcel 00 and 248 - new Wastewater Facility
12. Rotary Development LLC - 152 acres currently vacant - 85,000 sq. ft. commercial and 300 residential units permitted
13. Bourne Police Station (new location)
14. USACE dredging project and placement of sand on Town Neck Beach likely to take place in the fall of 2019 (Pers. Communication with Barbara Newman, 2019);
15. 665 Scenic Hwy - Bourne - Map 10 Parcel 10 - Cape Cod Aggregate gravel operation currently carrying out closure

There are no other known past or reasonably foreseeable future actions in the project vicinity that would change the cumulative impact determination for the proposed bridge rehabilitation/ replacement alternatives. The effects of the preferred alternative of bridge replacement - 4 lanes with 2 auxiliary lanes, in combination with other past, present and reasonably anticipated future actions are not expected to have any significant cumulative effects.

8.0 PUBLIC INVOLVEMENT

USACE regulations (the Planning Guidance Notebook – ER 1105-1-100) and the National Environmental Policy Act (NEPA) require that all efforts be made to involve the public in preparing and implementing NEPA procedures and to hold public meetings whenever appropriate (USACE NEPA Implementing Procedures 33 CFR Part 230, CEQ 40 CFR 1500-1508).

The USACE encourages stakeholder engagement, collaboration, and coordination for all projects and decision-making processes (USACE, 2019). Agencies, organizations, federally recognized Tribes, and members of the public with a potential interest in a proposed project were kept informed and invited to participate in the decision-making process for this project. Appendix E provides a record of agency and Tribal coordination and public involvement associated with the development of this EA.

The USACE involved the public early in the bridges study planning process to provide open communication and enable better federal decision-making. A series of five public informational meetings were held during the first two weeks of December 2018. These meetings introduced the MRER, environmental assessment process, and project timelines. The meetings were held in Bourne, Plymouth, Hyannis, Martha's Vineyard, and Nantucket, MA.

A project website (www.CapeCodCanalBridgesStudy.com) was developed to keep the public informed of presentations, fact sheets, documents, and provided an additional option for submitting public comments. One hundred two public comment letters or e-mails were received to date and were compiled into a matrix for consideration (Appendix F). EA Table 35 below categorizes the types of comments received.

In October 2019, another series of five public meetings was held on Cape Cod, the South Shore and in Boston to allow the opportunity for comments on this phase of the project and the draft EA. The public was notified of the public meetings and the official comment period through various forms of media including a Public Notice published on the Corps' publicly available website, through USACE sponsored social media (Facebook and Twitter), televised news reports on local and regional television stations, local news radio shows, and numerous newspaper articles on the topic of the draft report recommendation. A list of these notifications are included in Appendix F.

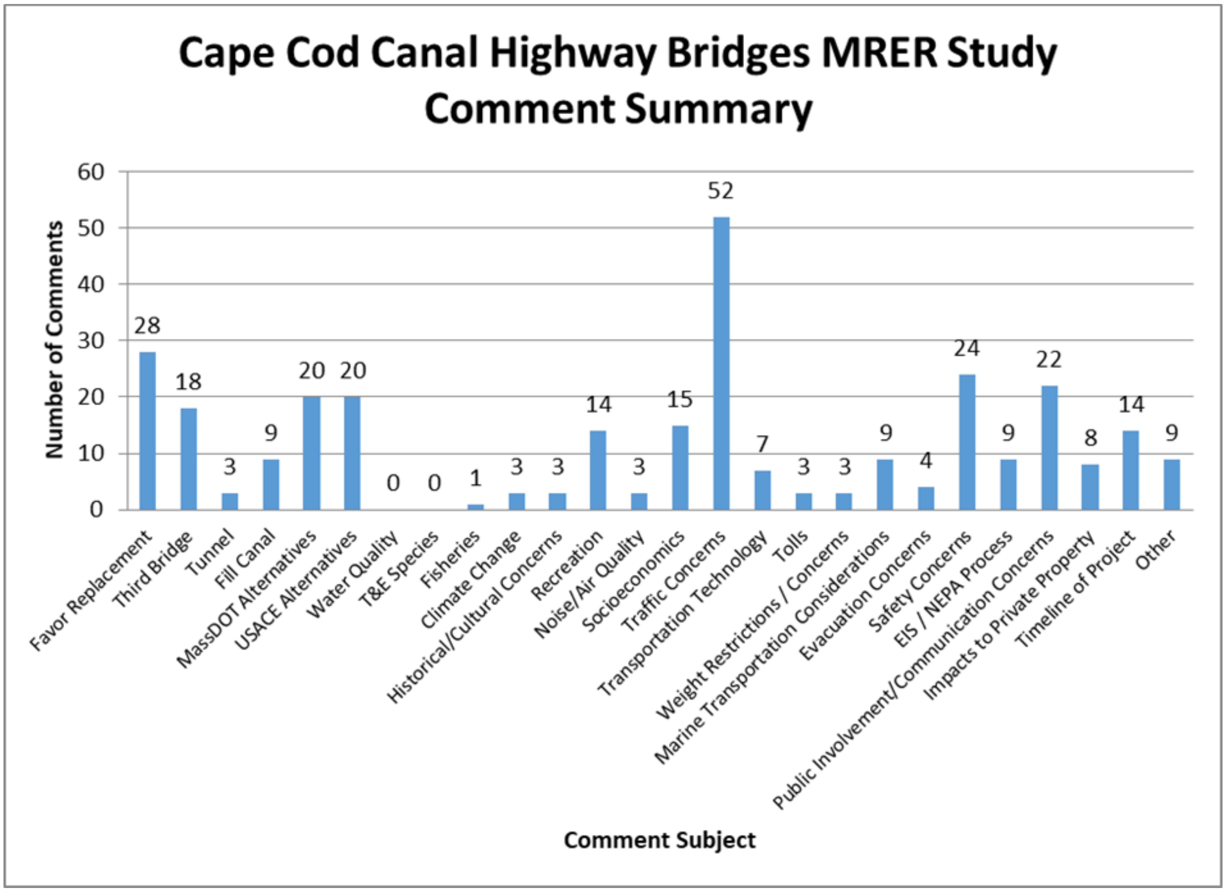
The USACE conducted a 30-day public comment period commencing on 03 October 2019. Prior to the conclusion of the 30-day public comment period, the USACE elected to extend the comment period for another 15 days, concluding the comment period on 15 November 2019. The USACE accepted comments via the agency recommendation meetings, the project website, electronic mail, and regular mail for consideration in the development of the Final MRER and EA. A total of 345 comments were received between 3 October 2019 and 15 November 2019 following publication of the Draft MRER/EA.

Additional public informational meetings will be scheduled during Phase II of the project to discuss the status of the project, design and construction details, and other key project considerations.

8.1 Initial Study Comments – Pre-draft

The United States Army Corps of Engineers (USACE) held a series of five public information meetings in December 2018 prior to issuance of the Cape Cod Canal Highway Bridges Draft MRER and EA. The USACE accepted comments during these public meetings as well as through the project website, electronic mail (e-mail), and regular mail for consideration in the development of the Draft MRER and EA. The following is a summary of the public comments (103 total comments) received between 4 December 2018 and 2 October 2019 prior to publication of the Draft MRER/EA on 3 October 2019. The comments received during this time period are shown in EA Table 35.

EA Table 35 – Pre-Draft Public Comments Summary



The majority of comments received prior to the issuance of the Draft MRER/EA were related to traffic concerns. Fifty-two (52) public comments were received noting a need to correct the traffic congestion regularly occurring on the Cape Cod Canal highway bridges (the "Bridges), nearby roadways, and roadways throughout Cape Cod, especially during the peak summer tourist season.

Twenty-eight (28) comments were received in support of replacing the Bridges, and these same comments overwhelmingly expressed concern that the current Bridges are unsafe for use. Twenty-four (24) comment submissions related to safety concerns with the condition of the current Bridges. The majority of the individuals believe the two existing Bridges are unsafe and pose a safety issue for motorists from motor vehicle accidents due to the narrow travel lanes, the high speeds traveled by commuters, and the lack of medians between the on and off-going traffic.

Twenty-four (24) comments were directed towards potential alternatives that the USACE identified and presented at public information meetings or additional alternatives that should be explored within the MRER and multiple commenters expressed their disappointment that too few alternatives were analyzed.

Twenty-three (23) public comments were directed towards alternatives to surrounding approach roadways or other regional roadway infrastructure that the Massachusetts Department of Transportation (MassDOT) is either responsible for or should explore.

Twenty-two (22) comments addressed the need for greater public involvement and increased or better communication during the process of designing and planning for the future of the Bridges.

Other comments addressed the following topics:

- Construction of a third bridge (18)
- Socioeconomics (15)
- Timeline of the project (14)
- Recreation (14)
- Marine transportation considerations (9)
- Miscellaneous comments (9)

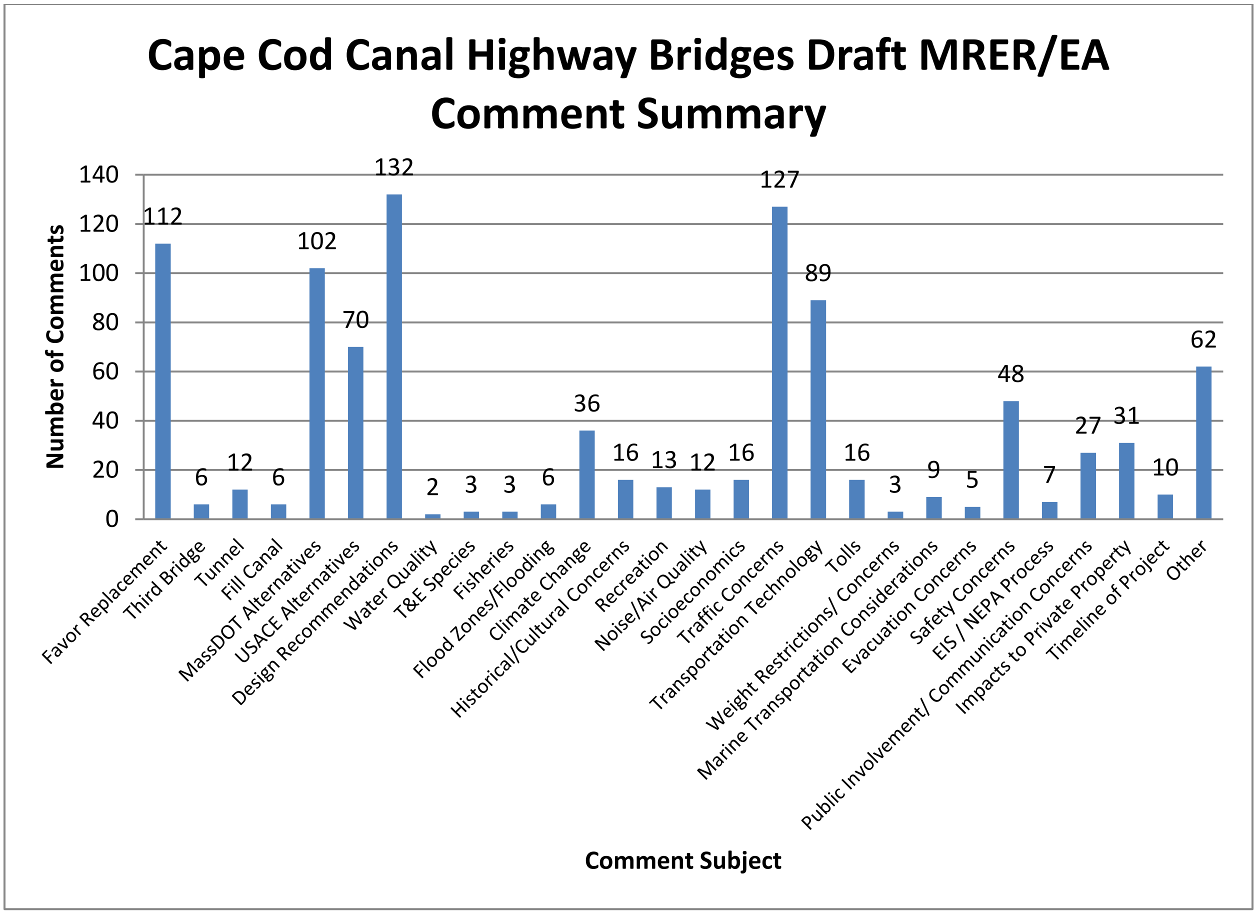
8.2 Draft EA Public Comments

The Cape Cod Canal Highway Bridges Draft MRER and EA was released on October 3, 2019 for a 30-day public comment period. Following the release of the draft report and EA, USACE held 5 public meetings in the communities of Bourne, Plymouth, Boston, Eastham, and Hyannis to solicit comments and questions from the public, and allow USACE to directly respond to questions received during the meetings.

Prior to the conclusion of the 30-day public comment period, USACE elected to extend the comment period for another 15 days, concluding the comment period on November 15, 2019. Comments were received during public meetings, through the project website, electronic email, and regular mail for consideration in the development of the Final MRER and EA.

A total of 345 comments were received between October 3, 2019 and November 15, 2019. All of the public comments received were reviewed and accounted for. Comments were grouped thematically and addressed by either amending sections of the EA, clarifying its final language, or adding analysis to the EA (EA Table 36). Specific groups of comments, and where these comments are addressed in the EA, can be found in Appendix F.

EA Table 36 – Post-Draft Public Comments Summary



The largest number of comments received addressed the design of replacement bridges, traffic concerns, and potential Mass DOT alternatives that could resolve traffic congestions concerns.

One hundred and twelve (112) public comments have been received to date which are in favor of replacement of both the Bourne and Sagamore Bridges.

Comments expressing opinions, histories, or experiences without reference to a specific issue or concern are also included in the Public Comment record (Appendix F). A summary of all public comments is located in Appendix F.

One hundred and thirty-two (132) draft EA public comments were related to design recommendations for the replacement bridges including: requests for the new bridge systems to incorporate bicycle and pedestrian lanes as well as public transportation systems; designating specific travel lanes for high occupancy vehicles and buses to reduce single-car use on Cape Cod; preserving the current appearance of the Bridges when engineering a new design; installing solar photovoltaic panels to offset energy needs and lighting requirements of the bridges; factoring future sea-level rise into the design; climate change, and the potential effects of a 100-year flood event on the project siting, bridges, and associated infrastructure; and the ability to accommodate electric transmission cables on or under the bridges.

One hundred and twenty-seven (127) public comments were received in response to the Draft MRER/EA, identifying a need to resolve local traffic issues associated with the Bridges and approach roadways; however, multiple individuals expressed concerns with adding higher traffic capacity bridges, as they believe it will encourage additional visitors to the Cape Cod region and increase traffic flows onto local roadways and communities.

One hundred and two (102) public comments were received regarding potential MassDOT alternatives that could assist with alleviating traffic congestion around the Sagamore and Bourne Bridges. A significant number of participants recognize the bridges are in need of replacement and also serve as a primary source of the traffic congestion; however, most believe there will be no net improvement to traffic congestion unless the approaching highway systems and local roadways that support travel near the Bridges are modified to facilitate the flow of traffic.

Several comments received were related to the incorporation of a tolling system on the new bridges. There are currently no tolls in place on the Cape Cod Canal highway bridges. The Corps of Engineers has no plans to implement tolling on the bridges.

Other comments addressed the following topics:

- Incorporation of alternative transportation technology (89)
- Potential alternatives being considered by the USACE (70)
- Miscellaneous comments (62)
- Safety concerns (48)
- Climate change (36)
- Impacts to private property (31)
- Communication concerns and requests for additional agency collaboration with landowners, municipal offices and various non-government organizations (27)
- Implementation of tolls (16)
- Potential economic impacts (16)
- Impacts to recreation (13)
- Construction of a tunnel (12)
- Noise and air quality (12)
- Timeline of the project (10)
- Marine transportation considerations (9)
- EIS and the NEPA process (7)
- Construction of a third bridge (6)
- Filling the Canal (6)
- Flood zones and flooding (6)
- Evacuation concerns (5)

Topics such as impacts to fisheries, impacts to threatened and endangered species, weight restrictions and concerns, and water quality received less than five (5) comments each.

9.0 AGENCY COORDINATION

NEPA requires lead Federal agencies to coordinate with other governmental agencies early in a project and throughout the NEPA process. CEQ regulations state that a lead agency can invite other Federal agencies, Tribes, or State or local agencies that have jurisdiction by law or special expertise to participate as a cooperating agency in the NEPA process. The benefits of cooperating agency participation include: “disclosure of relevant information early in the process; receipt of technical expertise and staff support; avoidance of duplicative reviews by Tribal, State, and local entities; and establishment of a mechanism for addressing inter- and intra- governmental issues and enhancing inter- and intra-agency and governmental trust” (CEQ, 2016). While cooperating agencies are more commonly utilized during the preparation of an EIS, they can be invited to be involved in an EA as well.

For the Bourne and Sagamore Bridges MRER Phase I project, five agencies were invited to participate as cooperating agencies: MassDOT, Federal Highway Administration (FHWA), U.S. Coast Guard, EPA and National Marine Fisheries Service. All agencies accepted (Appendix E).

Representatives from the following Federal, state, and local agencies with interest or jurisdiction in the proposed project were invited to a scoping meeting and coordinated site visit on March 19, 2019. Fifteen members attended (sign in sheets Appendix E).

Federal

U.S. Fish and Wildlife Service
U.S. Environmental Protection Agency
U.S. National Marine Fisheries Service
U.S. Coast Guard
Federal Highway Administration

State

Massachusetts Department of Transportation
Massachusetts Office of Coastal Zone Management
Massachusetts Department of Environmental
Protection Massachusetts Department of Fish and
Game Massachusetts Division of Fisheries and
Wildlife Massachusetts Division of Marine Fisheries
Massachusetts Historic Preservation Office
Massachusetts Board of Underwater Archaeological Resources*

Tribal Governments

Wampanoag Tribe of Gay Head
(Aquinnah) Wampanoag Tribe of
Mashpee

Local

Bourne Conservation Commission
Sandwich Conservation Commission
Sandwich Historic Commission Bourne
Historic Commission*

(*separate coordination)

Early coordination was also conducted with several resource agencies including: U.S. Fish and Wildlife Service, National Marine Fisheries Services, MA Office of Coastal Zone Management and MA Historic Preservation Office to discuss project plan formulation and consider potential impacts to specific resources and agency comments and concerns. Consultations will continue during Phase II of the project.

10.0 COMPLIANCE WITH ENVIRONMENTAL FEDERAL STATUTES AND EXECUTIVE ORDERS

Item	**Citation**	**Compliance**
Federal Statutes		
Clean Air Act	42 U.S.C. §§ 7401 et seq.	A preliminary air quality analysis for modeled increased traffic was completed by MassDOT (appendix). Public notice of the availability of the Environmental Assessment to the USEPA is required for compliance pursuant to Sections 176c and 309 of the Clean Air Act. A Public Notice will be published and coordination with the USEPA is on-going.
Clean Water Act	33 U.S.C. 1251 et seq.	An application for a State Water Quality Certification pursuant to Section 401 of the Clean Water Act will be filed with the Commonwealth of Massachusetts if deemed necessary during the design phase.
Coastal Zone Management Act	16 U.S.C. §§ 1451-1464	Preliminary Coastal Zone Management Consistency Determination submitted to the Massachusetts Coastal Zone Management (CZM) Program for concurrence. CZM will respond after reviewing the Draft EA.
Endangered Species Act of 1973	16 U.S.C. 1531 et seq.	USACE Section 7 Coordination with USFWS and NMFS is on-going regarding threatened and endangered species.

Fish and Wildlife Coordination Act	16 U.S.C. 661 *et seq.*	Coordination with the USFWS, NMFS, and State fish and wildlife agencies fulfills compliance with the Fish and Wildlife Coordination Act. Coordination is on-going.
Magnuson-Stevens Act Fishery Conservation and Management Act	16 U.S.C. 1855(b)(2)	Coordination with the NMFS and preparation of an EFH Assessment fulfills compliance with the EFH provisions of the Magnuson-Stevens Act. Coordination with the NMFS is on-going.
National Environmental Policy Act of 1969	42 U.S.C. 432 et seq.	Preparation of an Environmental Assessment and accompanying Finding of No Significant Impact (FONSI) fulfills compliance requirements for NEPA.
National Historic Preservation Act of 1966	16 U.S.C. 470 et seq.	Compliance is established through consultation and development of a MOA. In this case, consultation with the SHPO and the Tribal Historic Preservation Officer is continuing and a Memorandum of Agreement will be developed in consultation with the SHPO, THPOs, and local interested parties during the design phase to develop a plan to avoid, minimize, or mitigate the effects of bridge replacement on historic properties.
Preservation of Historic and Archeological Data Act of 1974	54 USC 470 et seq.	Coordination with the State Historic Preservation Act signifies compliance. Coordination is ongoing.
Archaeological Resources Protection Act of 1979	16 U.S.C. 470 et seq.	Not applicable to this project.
American Indian Religious Freedom Act of 1978	42 U.S.C. 1996	This project not likely to impede access by Native Americans to sacred sites, possession of sacred objects, and the freedom to worship through ceremonials and traditional rites.
Estuarine Areas Act	16 U.S.C. 1221 et seq.	Not applicable to this project.
Federal Water Project Recreation Act, as amended	16 U.S.C. 4601 12 et seq.	Public notice of availability of the Environmental Assessment to the National Park Service (NPS) and Office of Statewide Planning relative to the Federal and State comprehensive outdoor recreation plans signifies compliance with this Act.

Land and Water Conservation Fund Act of 1965, as amended	16 U.S.C. 4601 4 et seq.	Public notice of availability of the Environmental Assessment to the National Park Service (NPS) and Office of Statewide Planning relative to the Federal and State comprehensive outdoor recreation plans signifies compliance with this Act.
Marine Protection, Research, and Sanctuaries Act of 1971, as amended	33 U.S.C. 1401 et seq.	Not applicable to this project.
Marine Mammal Protection Act of 1972	16 U.S.C. 1361-1407	Coordination with the USFWS, NMFS, and State fish and wildlife agencies fulfills compliance with the Marine Mammal Protection Act. Coordination is ongoing.
Native American Graves Protection and Repatriation Act (NAGPRA)	25 U.S.C. 3000-3013, 18 U.S.C. 1170	Regulations implementing NAGPRA will be followed if discovery of human remains and/or funerary items occur during implementation of this project.
Rivers and Harbors Act of 1899, as amended	33 U.S.C. 401 et seq.	Not subject to Section 10 of the Rivers and Harbors Act per 33 U.S.C 403. Ongoing coordination with U.S. Coast Guard during the design phase of the project to determine if bridge construction permit is needed.
Watershed Protection and Flood Prevention Act as amended	16 U.S.C 1001 et seq.	Not applicable to this project.
Wild and Scenic Rivers Act, as amended	16 U.S.C 1271 et seq.	Not applicable to this project.
Coastal Barrier Resources Act, as amended	16 U.S.C. 3501 et seq.	Both bridges are located outside of the Coastal Barrier Resources System.

Executive Orders

Protection of Wetlands	Executive Order 11990	The replacement of the bridges would impact the man-made drainage ponds on the northern side of the Sagamore bridge, a 0.5 acre forested wetland 500 ft. east of the southern side of the Bourne Bridge and adjacent to the railroad tracks, as well as a small area of forested wetland on the northern side of the Bourne Bridge approach. Wetlands will be avoided to the extent possible, and any impacts would be mitigated for.
Protection of Children from Environmental Health and Safety Risks	Executive Order 13045	The project will not create a disproportionate environmental health or safety risk for children.
Protection and Enhancement of the Cultural Environment	Executive Order 11593	Coordination with the State Historic Preservation Officer signifies compliance.
Floodplain Management	Executive Order 11988	Replacement of the Bourne and Sagamore Bridges will not impact floodplains.
Environmental Effects Abroad of Major Federal Actions	Executive Order 12114	Not applicable to projects located within the United States.
Environmental Justice in Minority and Low Income Populations	Executive Order 12898	USACE performed an analysis and has determined that a disproportionate negative impact on minority or low-income groups in the community is not anticipated; a full evaluation of Environmental Justice issues is not required.
Federal Leadership in Environmental, Energy, and Economic Performance	Executive Order 13514	Not applicable to this project.
Improve the Resilience of Communities and Federal Assets Against the Impacts of Flooding Due to the Effects of Climate Change and Other Threats, 30 January 2015	Executive Order 13690	During Phase II of the project, USACE will incorporate considerations for potential sea level change into the design analyses so both bridges can accommodate and withstand any projected sea-level change.

Accommodation of Sacred Sites	Executive Order 13007	Access to and ceremonial use of Indian sacred sites by Indian religious practitioners will be allowed and accommodated. No adverse effects to the physical integrity of such sacred sites is anticipated.
Federal Support of Community Efforts Along American Heritage Rivers	Executive Order 13061	Not applicable to this project.
Federal Agencies may not authorize, fund, or carry out actions likely to cause or promote the introduction or spread of invasive species	Executive Order 13122	The project will not promote the introduction or spread of invasive species.
Consultation and Coordination with Indian Tribal Governments	Executive Order 13175	Consultation with Indian Tribal Governments, where applicable, and consistent with executive memoranda, DoD Indian policy, and USACE Tribal Policy Principles signifies compliance.
Executive Memorandum		
Analysis of Impacts on Prime or Unique Agricultural Lands in Implementing NEPA		Not applicable; the project does not involve or impact agricultural lands.
White House Memorandum, Government-to-Government Relations with Indian Tribes		Consultation with Federally Recognized Indian Tribes signifies compliance.

Accompanying Documents

References

Appendices

FINDING OF NO SIGNIFICANT IMPACT
Cape Cod Canal Highway Bridges
Bourne, Massachusetts

Major Rehabilitation Evaluation Report
Phase I Environmental Assessment

The U.S. Army Corps of Engineers New England District (Corps), conducted an environmental analysis in accordance with the National Environmental Policy Act of 1969, as amended. The Cape Cod Canal Major Rehabilitation Evaluation Report (MRER) and Environmental Assessment (EA), dated March 2020, for the Cape Cod Canal Bourne and Sagamore bridges is a decision document, which will provide the basis for the Corps and Congress to determine the most cost-effective, safe and practicable alternative for providing critical public transportation across the Cape Cod Canal, a Federal Navigation Project (FNP). The MRER includes engineering, economic and environmental analyses and evaluates alternatives including: continued repair and maintenance, major rehabilitation, or replacement of both bridges with new structures to address bridge component deficiencies which impact their structural and operational reliability.

The MRER decision document and accompanying EA are focused on the decision of whether to perform a major rehabilitation of the bridges, replace the bridges with new structures, or continue existing repair as needed (No Action Alternative). The Corps will address design and construction considerations and perform additional environmental analyses specific to the recommended plan in a subsequent EA.

The recommended plan includes replacement of both the Bourne and Sagamore bridges with new bridges consisting of 4 lanes with 2 auxiliary lanes each. New bridges would be built adjacent to the existing bridges and will incorporate modern safety design standards such as 12-foot wide travel lanes (compared to 10-foot widths currently on the existing bridge decks); pedestrian and bicycle lanes with a separation barrier from the vehicle lanes; a median between the two directions of vehicular travel; and shoulders to accommodate vehicle breakdowns. Bridge abutments would be located further north and south of their present locations on each side of the Canal in order to produce approach grades consistent with modern federal highway standards. The existing bridge piers are currently located within the Canal. New bridge piers would be relocated out of the water to the Canal shoreline.

The current bridges would remain open and continue to be inspected and maintained in a safe and reliable state while construction of the new bridges was underway. The current bridges would be dismantled after the new bridges have been opened to traffic. The actual bridge type, design specifications, and location of new bridges will be determined and evaluated during the design phase of the Cape Cod Canal Highway Bridges Project.

Based on my review and evaluation of environmental effects as presented in the March 2020 MRER) and EA I have determined that Phase I of the Cape Cod Canal Bridges project is not a major federal action significantly affecting the quality of the human environment. Under the Council on Environmental Quality (CEQ) NEPA regulations, "NEPA significance" is a concept dependent upon context and intensity (40 C.F.R. § 1508.27). When considering a site-specific action like the proposed project, significance is measured by the impacts felt at a local scale, as opposed to a regional or nationwide context. The CEQ regulations identify a number of factors to measure the intensity of impact. These factors are discussed below, and none are implicated here to warrant a finding of NEPA significance. A review of these NEPA "intensity" factors reveals that the proposed action would not result in a significant impact - neither beneficial nor detrimental - to the human environment.

Summary of Potential Effects:
For all alternatives, the potential effects were evaluated, as appropriate.

Impacts on Public Health or Safety: The project is expected to have no significant adverse effect on public health and safety. The project involves replacement of two existing bridges.

Unique Characteristics: The development of a programmatic agreement with the MA State Historic Preservation Officer (SHPO) will address any potential impacts to historic properties or cultural resources to ensure there will be no significant impacts to any unique characteristics within the communities.

Controversy: This project was coordinated with federal, state, local agencies, stakeholders and the public with jurisdiction or interest in the project. All comments were addressed with no significant controversy uncovered.

Uncertain Impacts: The impacts of this phase of the proposed bridge replacement project are not uncertain. They are readily understood based on past transportation projects and other similar Corps projects. Additional analyses will be conducted during the design phase to better assess other potential impacts.

Precedent for Future Actions: The proposed project involves replacement of an authorized project and will not establish a precedent for future actions other than future maintenance activities.

Cumulative Significance: The Massachusetts Department of Transportation (MassDOT) conducted a Cape Cod Canal Transportation Study. The final report included recommended plans for transportation improvement projects in the vicinity of the bridge replacement projects. These infrastructure improvement projects are in concept only. No plans have been identified for implementation and no funding or authorization has been obtained. Any future MassDOT Cape Cod transportation improvement projects are uncertain at this phase. If identified in the future, further analysis will be conducted during the design phase of the bridge project. As discussed in the EA, the effects of the proposed action in combination with other past, present and reasonably anticipated future actions are not expected to have any significant cumulative effects. There are no significant cumulative impacts to communities, fish and wildlife, or federal and/or state threatened and endangered species.

Historic Resources: Pursuant to Section 106 of the National Historic Preservation Act of 1966, as amended, the Corps has determined that historic properties may be adversely affected by the recommended plan. Additional consultation with the SHPO and the Tribal Historic Preservation Officer (THPO) on the location of the bridges and the design will be required during the design phase of the project. A Memorandum of Agreement will be developed in consultation with the SHPO, THPOs, and local interested parties during the design phase to develop a plan to avoid, minimize, or mitigate the effects of bridge replacement on historic properties. All terms and conditions resulting from the agreement shall be implemented in order to minimize adverse impacts to historic properties. The project will have no known effects on any pre-contact archaeological sites recorded by the Commonwealth of Massachusetts.

Endangered Species: At this phase of the project, we have not identified any unavoidable impacts on any federal or state threatened or endangered species. The Corps has begun coordination with the U.S. Fish and Wildlife Service (USFWS) and the National Marine Fisheries Service (NMFS) for technical assistance. Coordination with the USFWS indicated that federally-threatened northern long-eared bat (NLEB) may be present in the project area; however, because NLEB change locations over time, the USFWS indicate that it would be more effective to conduct surveys closer to the time of actual construction activities. The Corps will consult with the USFWS pursuant to Section 7 of the Endangered Species Act (ESA) during the design phase to determine if NLEB are present and identify measures necessary to minimize potential impact. These measures can be addressed through design changes and construction timing; therefore, no significant impacts to threatened and endangered species are anticipated.

The Corps held a conference call regarding ESA Section 7 consultation for marine species with the NMFS on May 20, 2019. Their greatest concern among ESA-listed species is the North Atlantic right whale. The timing of all bridge work will be scheduled to protect right whales that may transit through the Canal. In order to avoid adverse effects to marine species during construction, the Corps will carefully monitor the Canal for the presence of protected species. If any marine mammals or sea turtles are identified during bridge replacement in-water construction activities, all work will cease until the animal is safely out of the affected area. The Corps will consult with the NMFS during the design phase of the project to protect federally-listed marine species.

Mitigation measures will be identified during the design phase of the project in coordination with the USFWS and the NMFS to avoid and minimize impacts.

Potential Violation of State or Federal Law: This action will not violate federal or state laws. Measures to minimize adverse environmental effects of the proposed action are discussed in

Section 6 of the EA. All work will be performed in accordance with applicable environmental regulations, which will minimize environmental impacts. The project will include the use of protective measures such as Best Management Practices and specific mitigation measures, which will be developed during the design phase.

Based on my review and evaluation of the environmental effects as presented in the August 2019 MRER and EA, I have determined that replacement of the Bourne and Sagamore bridges is not a major federal action significantly affecting the quality of the human environment. This project, therefore, is exempt from requirements to prepare an Environmental Impact Statement.

____________________ Date	______________________________ William M. Conde Colonel, Corps of Engineers District Engineer

CAPE COD CANAL HIGHWAY BRIDGES
MAJOR REHABILITATION EVALUATION REPORT
AND ENVIRONMENTAL ASSESSMENT

REFERENCES

1) Bradley, Michael (editor), (1993). Bourne Village: An Oral History. Bourne Historic Commission, Bourne, Massachusetts.

2) Bureau of Labor Statistics. (2017). County Employment and Wages in Massachusetts – Second Quarter 2016. News Release 17-37-BOS. New England Information Office. Boston, MA. 8 pp.

3) Cape Cod Chamber of Commerce. (2016). Tourism Statistics. http://www.whycapecod.org/tourism-statistics.html. Retrieved July 2017.

4) Cape Cod Commission. (2010). Barnstable County Cape Cod, Massachusetts Multi-Hazard Mitigation Plan. March 19, 2010. Barnstable, MA. 74 pp.

5) Cape Cod Commission. (2012 and 2013). Regional Wastewater Management Plan. Accessed on February 15, 2019. <http://www.capecodcommission.org/resources/RWMP/RWMP_ea_land.pdf>

6) Cape Cod Commission. (2014). Barnstable County High Crash Locations. June 2014. Barnstable, MA. 30 pp.

7) Cape Cod Commission. (2017). Cape Cod's Sole Source Aquifer. Accessed on February 28, 2019. http://www.capecodcommission.org/index.php?id=169.

8) Cape Cod Commission. (2017a). Cape Cod Comprehensive Economic Development Strategy (CEDS) Annual Report (Year 3). June, 2017. Barnstable, MA. 283 pp.

9) Cape Cod Commission. (2017b). Impact of Cape Cod Canal Bridge Lane Closures. Memo prepared for Sharon Pailler, Army Corps of Engineers. August 15, 2017. Barnstable, MA. 9 pp.

10) Cape Cod Healthcare. (2016). Community Health Needs Assessment Report and Implementation Plan 2017-2019. Cape Cod Hospital and Falmouth Hospital. 80 pp.

11) Cape Cod Metropolitan Planning Organization (CCMPO). (2015). Cape Cod 2016 Regional Transportation Plan 2016-2040. Cape Cod Commission. 98 pp.

12) Commonwealth of Massachusetts. (2013). State Hazard Mitigation Plan. 721 pp.

13) Commonwealth of Massachusetts. (2016) Cape Cod Emergency Traffic Plan. 38 pp.

14) Commonwealth of Massachusetts. (2018). State Hazard Mitigation Plan.

15) Crane Associates Team. Barnstable County Demographic and Economic Forecast: Executive Summary. April 12, 2017. 6 pp.

16) Daley, Patricia. (2015). Re: Proposed Cape Cod Canal Study Transportation Model. Received by Ethan Britland, 7 October 2015.

17) Davin, Ann. (1994). Historic and Archaeological Reconnaissance/Inventory Survey, Cultural Resource Management Plan, Cape Cod Canal, Bourne, Sandwich, and Wareham, Massachusetts. Prepared by The Public Archaeology Laboratory, Inc.

18) DeCaesare, G.J., S.G. Connors. (2002). Cape Cod Watershed: Water Quality Assessment Report. Massachusetts Department of Environmental Protection. Report No. 96-AC-1. https://www.mass.gov/files/documents/2016/08/nu/96wqar.pdf.

19) Doherty, Joanna M., Matthew A Kierstead, Virginia H. Adams (2000). Historic Inventory Survey, Cape Cod Canal, Bourne, Sandwich, and Wareham, Massachusetts. Submitted to the U.S. Army Corps of Engineers, New England District by The Public Archaeology Laboratory, Inc.

20) Dunn, Alexandra. May 18, (2018). The Time to Act of Cape Cod Water Quality is Now. Environmental Protection Agency News Release. https://www.epa.gov/newsreleases/time-act-cape-cod-water-quality-now.

21) Dunning, Mark, and Susan E. Durden. (2009). Handbook on Applying “Other Social Effects” Factors in Corps of Engineers Water Resources Planning. Institute for Water Resources. 09-R-4. Unites States Army Corps of Engineers. 210 pp.

22) eBird.org. (2019a). Accessed: April 1, 2019. https://ebird.org/hotspots.

23) eBird.org. (2019b). Accessed: April 2, 2019. https://ebird.org/region/US-MA/regions?yr=all&m=.

24) ECONorthwest & Portland State University. (2001). A Guidebook For Evaluating the Indirect Land Use and Growth Impacts of Highway Improvements: Final Report. Prepared for Oregon Department of Transportation. April 2001. 68 pp.

25) Environmental Protection Agency (EPA). (2019a). Certification of Adequacy of the Massachusetts State Implementation Plan with Clean Air Act Section 110(a)(2)(D)(i) Interstate Air Pollution Transport Requirements for the 2008 Ozone National Ambient Air Quality Standards February 9, 2018. https://www3.epa.gov/region1/eco/drinkwater/capecod.html. MassDEP, 2018.

26) EPA. (2019b). Summary of Executive Order 12898 – Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations. https://www.epa.gov/laws-regulations/summary-executive-order-12898-federal-actions-address-environmental-justice. June 2019.

27) Fairchild, G.M., Lane, J.W., Jr., Voytek, E.B., and LeBlanc, D.R. (2013). Bedrock topography of western Cape Cod, Massachusetts, based on bedrock altitudes from geologic borings and analysis of ambient seismic noise by the horizontal-to-vertical spectral-ratio method: U.S. Geological Survey Scientific Investigations Map 3233, 1 sheet, maps variously scaled, 17-p. pamphlet, on one CD–ROM. (Also available at http://pubs.usgs.gov/sim/3233.)

28) Farson, Robert. (1993). The Cape Cod Canal, Second Edition. Cape Cod Historical Publications, Yarmouth Port, Massachusetts. Originally published 1977.

29) Federal Emergency Management Agency (FEMA) and United State Army Corps of Engineers (USACE). Massachusetts Hurricane Evacuation Study. 2015.

30) Hool, George A. and W.S. Kinne. (1943). Moveable and Long-Span Steel Bridges. McGraw Hill Book Company, Inc. New York, New York.

31) Joint Base Cape Cod. (2018). http://www.thenationsfirst.org/JBCC/index.html.

32) Keene, Betsey D. (1937). History of Bourne from 1622 to 1937. Sullwold Publishing, Taunton, Massachusetts. Reprinted 1975.

33) Lovell, R.A., Jr. (1984). Sandwich, A Cape Cod Town. Town of Sandwich, Massachusetts; Sandwich Archives and Historical Center.

34) Martha's Vineyard Commission. (2006). Population and Housing Profile of Martha's Vineyard. Oak Bluffs: MVC. March 20, 2006. 4 pp.

35) Massachusetts Department of Transportation (MassDOT) Crash Portal. Accessed 7/28/2017 http://services.massdot.state.ma.us/crashportal/DataRequest.aspx.

36) MassDOT. (2016a). Cape Cod Canal Transportation Study, Public Information Meeting Notes. April 16, 2016. http://www.massdot.state.ma.us/capecodcanalstudy/Documents.aspx.

37) MassDOT. (2019). Cape Cod Canal Transportation Study. https://www.mass.gov/cape-cod-canal-transportation-study.

38) Massachusetts Division of Fisheries and Wildlife (MA DFW). (2015a). Natural Heritage and Endangered Species Program (NHESP). "Roseate Tern Species Profile." Accessed on February 15, 2019. http://www.mass.gov/eea/docs/dfg/nhesp/species-and-conservation/nhfacts/roseate-tern.pdf.

39) MA DFW NHESP. (2015b). Eastern Box Turtle Species Profile. Accessed on February 15, 2019. http://www.mass.gov/eea/docs/dfg/nhesp/species-and-conservation/nhfacts/terrapene-carolina.pdf.

40) MA DFW NHESP. (2016). Northern Red-bellied Cooter Species Profile. Accessed on February 15, 2019. http://www.mass.gov/eea/docs/dfg/nhesp/species-and-conservation/nhfacts/pseudemys-rubriventris.pdf.

41) Massachusetts Executive Office of Energy and Environmental Affairs (MA EEA). (2001). Cape Cod Watershed Assessment. Accessed on September 7, 2016. http://www.mass.gov/eea/docs/eea/water/assess-rpt-capecod.pdf.

42) MA EEA. (2016). The Worst Hurricanes of the 20th Century. Accessed November 23, 2016. http://www.mass.gov/eea/agencies/czm/publications/pages/worst-hurricanes.html.

43) Massachusetts GIS. (2019). Munimapper: Bourne, MA. Accessed on February 21, 2019. http://maps.massgis.state.ma.us/map_ol/bourne.php.

44) MA NHESP. (2019). BioMap 2. Accessed on February 15, 2019. http://maps.massgis.state.ma.us/dfg/biomap2.htm.

45) Massachusets Office of Coastal Zone Management Office. (2019). Accessed online: https://www.mass.gov/federal-consistency-review-program.

46) Menzel, M. A., S. F. Owen, W. M. Ford, J. W. Edwards, P. B. Wood, B. R. Chapman, and K. V. Miller. (2002). Roost tree selection by northern long-eared bat (*Myotis septentrionalis*) maternity colonies in an industrial forest of the central Appalachian mountains. Forest Ecology and Management, 155(1): 107-114.

47) National Center for Environmental Information (NCDC) and National Oceanic and Atmospheric Administration (NOAA). (2016). Climate Data Online. Accessed June 6, 2019. https://www.ncdc.noaa.gov/cdo-web.

48) NCDC. (2017). Storm Events Database. National Oceanic and Atmospheric Administration (NOAA) retrieved July 27, 2017 from https://www.ncdc.noaa.gov/stormevents/.

49) National Cooperative Highway Research Program (NCHRP). (2002). Report 466, Desk Reference for Estimating the Indirect Effects of Proposed Transportation Projects. And Report 403, Guidance for Estimating the Indirect Effects of Proposed Transportation Projects.

50) National Environmental Policy Act (NEPA) of 1969, Public Law No. 91–190, Section 103, 83 Statute 852, 853 (1970).

51) National Fire Protection Association 9 (NFPA). (2016). 1710: Standard for the Organization and Deployment of Fire Suppression Operations, Emergency Medical Operations, and Special Operations to the Public by Career Fire Departments. 2016 Edition. Quincy, MA. 35 pp.

52) NOAA. (2013). Estimating vertical land motion from long-term tide gauge records, Technical report NOS CO-OPS 065, U.S. Department of Commerce, National Oceanic and Atmospheric Administration, Center for Operational Oceanographic Products and Services: Silver Spring, MD, Available at: http://tidesandcurrents.noaa.gov/publications/Technical_Report_NOS_CO-OPS_065.pdf.

53) NOAA. (2019). ESA Section 7 Mapper - ESA listed species under NOAA Fisheries Jurisdiction https://noaa.maps.arcgis.com/apps/webappviewer/index.html?id=1bc332edc5204e03b250ac11f9914a27.

54) NOAA. (2019). National Centers for Environmental Information Climate Data Online (CDO) https://www.ncdc.noaa.gov/cdo-web/datasets/NORMAL_ANN/locations/FIPS:25001/detail.

55) NOAA. (2019). Sea level trends, U.S. Department of Commerce, National Oceanic and Atmospheric Administration, Center for Operational Oceanographic Products and Services: Silver Spring, MD, Available at: http://tidesandcurrents.noaa.gov/sltrends/sltrends.html.

56) National Park Service (NPS). (2012). Historical Importance and Abundance of Cape Cod's Mammals. Accessed on February 15, 2019. https://www.nps.gov/caco/learn/nature/history-of-mammals.htm.

57) Parkman, Aubrey (1978). Army Engineers in New England. U.S. Army Corps of Engineers, New England Division, Waltham, Massachusetts.

58) Personal Correspondence: Barbara Newman, Chief of Permits and Enforcement Branch, USACE New England District. Email dated 7/24/19.

59) Personal Correspondence: Coreen Moore, Town Planner, Town of Bourne. Email dated 6/13/19.

60) Personal Correspondence: Deputy Fire Chief Pelonzi, Bourne Fire Department, in discussion with Sharon Pailler, USACE July 31, 2017.

61) Personal Correspondence: Leanne Drake, Assistant Town Planner, Town of Sandwich. Email dated 7/23/19.

62) Personal Correspondence: Lieutenant Brandon Esip, Bourne Police Department, in discussion with Sharon Pailler, USACE, March 13, 2018.

63) Personal Correspondence: Paul Rendon, Assistant to Joint Base Cape Cod Director, in discussion with Sharon Pailler, USACE, July 21, 2017.

64) Personal Correspondence: Theresa Ahern, Patrick Kane and Michael Lauf, Cape Cod Healthcare in discussion with Sharon Pailler, USACE, August 2, 2017.

65) Personal Correspondence: Wendy Northcross, CEO of the Cape Cod Chamber of Commerce in discussion with Sharon Pailler, USACE, August 8, 2017.

66) Reid, William J. (1961). The Cape Cod Canal. Privately printed by George McKibin and Son, Inc., New York, New York. Based on Ph.D dissertation for the Boston University Graduate School, Boston, Massachusetts.

67) Renski, Henry, Susan Strate, Danie Hidge, William Proulx, Katherine Paik, Steffen Herter. (2015). Long-term Population Projections for Massachusetts Regions and Municipalities. University of Massachusetts Donahue Institute. Amherst, MA. 77 pp.

68) Roper, Steven. (1990). Historic Bridge Survey Form for the Bourne Bridge, Bourne Massachusetts. Massachusetts Department of Public Works, Boston, MA.

69) Roper, Steven. (1990). Historic Bridge Survey Form for the Sagamore Bridge, Bourne, Massachusetts. Massachusetts Department of Public Works, Boston, MA.

70) Spectra Energy Partners, February 2014, Best Drilling Practices, Monitoring and Clean-up of Horizontal Directional Drilling Inadvertent Returns for the Algonquin Incremental Market Project.

71) Stantec. (2017) Cultural Resources Identification and Evaluation. Cape Cod Canal Transportation Study, Bourne, Sandwich, and Plymouth, Massachusetts. Prepared for submission to: The Massachusetts Department of Transportation. Prepared by: Archaeological and Historical Services, Inc.

72) Stasiowski, Carole, Karen Piatt, Shamoore Simpson. (2016). Community Health Needs Assessment. Spaulding Rehabilitation Hospital Cape Cod.

73) Stats Cape Cod. (2015). Population by Town. http://www.statscapecod.org. Cape Cod Commission. Retrieved July 7, 2017.

74) Stats Cape Cod. (2015). Population by Town. http://www.statscapecod.org. Cape Cod Commission. Retrieved July 7, 2017.

75) The Chesapeake Group. (2013). Market Assessment for Cape Cod, Massachusetts. Prepared for the Cape Cod Commission. 96 pp.

76) UMass Donahue Institute. (2008). 2008 Survey of Cape Cod Second-Home Owners. University of Massachusetts, Donahue Institute, Research and Evaluation Group. November 2008. 65 pp.

77) UMass Donahue Institute. (2012). Cape Cod Business Climate Survey. University of Massachusetts, Donahue Institute, Research and Evaluation Group. May 2012. 44 pp.

78) USACE, 1982. *Air Monitoring at the Sagamore Bridge Cape Cod canal, Massachusetts. Final Report October 1982* Contract No. DACW 33-81-C-0125 prepared by Air Quality Consultants (AQC).

79) U.S. Army Corps of Engineers (USACE). (1998). Painting of the Sagamore Highway Bridge, Cape Cod Canal. Bourne, MA. Construction Solicitation and Specifications Job Hazard – Lead Paint.

80) USACE. (2013). Engineer Regulation, Incorporating Sea-Level Change in Civil Works Programs, Regulation No. 1100-2-8162, Department of the Army: Washington, DC, Available at: http://www.publications.usace.army.mil/Portals/76/Publications/EngineerRegulations/ER_1100-2-8162.pdf.

81) USACE. (2014). Engineering Technical Letter, Procedures to Evaluate Sea Level Change: Impacts, Responses, And Adaptation, Technical Letter No. 1100-2-1, United States Army Corps of Engineers: Washington, DC, Available at: http://www.publications.usace.army.mil/Portals/76/Publications/EngineerTechnicalLetters/ETL_1100-2-1.pdf.

82) USACE. (2015). Final Environmental Assessment, Finding of No Significant Impact, and Section 404(b)(1) Evaluation for Maintenance Dredging and Beneficial Use of Dredged Material for Beach Nourishment: Cape Cod Canal, Bourne and Sandwich, MA, and Town Neck Beach, Sandwich, MA.

83) USACE. (2017). Final Environmental Assessment and Finding of No Significant Impact, Cape Cod Canal, Bourne MA, Solar Photovoltaic Installation.

84) USACE. (2019). Cape Cod Canal. https://www.nae.usace.army.mil/missions/recreation/cape-cod-canal/. Retrieved June 2019.

85) USACE. 2019, Engineering Pamphlet (EP) 1105-2-57 Stakeholder Engagement, Collaboration, and Coordination.

86) United States Census Bureau. American Community Survey. (2015). Retrieved from https://www.census.gov/acs/www/data/data-tables-and-tools/data-profiles/2015/.

87) U.S. Department of Transportation (USDOT). Federal Highway Administration, FINAL REPORT Noise Measurement Handbook 6.1.2018, FHWA-HEP-18-065.

88) U.S. Fish and Wildlife Service (USFWS). (1998). Roseate Tern Recovery Plan – Northeastern Population, First Update. Hadley, MA. 75 pp.

89) USFWS. (2015). Bayville, New York Coastal Storm Risk Management Feasibility Study, U.S. Fish and Wildlife Service Draft Planning Aid Report. Print. Dated 2 October 2015.

90) USFWS. (2019a). American Chaffseed *Schwalbea Americana.* Accessed on March 1, 2019. https://www.fws.gov/southeast/wildlife/plants/american-chaffseed/.

91) USFWS and USACE. February 26, 2019b. Teleconference, Concord, NH, and Concord, MA. Subject: Endangered Species Act Technical Assistance related to Cape Cod Canal Bridges MRER.

92) USFWS and USACE. April 1, 2019. Teleconference, Concord, NH and Concord, MA. Subject: Technical Assistance related to presence of migratory, threatened, and endangered birds in and around the Cape Cod Canal.

93) U.S. Geological Survey (USGS). (1999). Cape Cod USGS Projects. Accessed on February 15, 2019. http://ma.water.usgs.gov/basins/capecod.htm.

94) USGS. (2003). Land Cover Trends: Atlantic Coastal Pine Barrens. Accessed on March 27, 2019. https://pubs.usgs.gov/fs/2003/0092/report.pdf

95) USGS. Geological History of Cape Cod, Massachusetts. Accessed on February 15, 2019. https://pubs.usgs.gov/gip/capecod/glacial.html.

96) Walter, D.A., Masterson, J.P., and Hess, K.M. (2004). Ground-Water Recharge Areas and Traveltimes to Pumped Wells, Ponds, Streams, and Coastal Water Bodies, Cape Cod, Massachusetts, Scientific Investigations Map I-2857, 1 sheet.

97) Walter, D.A., McCobb, T.D., Masterson, J.P., and Fienen, M.N., 2016, Potential effects of sea-level rise on the depth to saturated sediments of the Sagamore and Monomoy flow lenses on Cape Cod, Massachusetts (ver. 1.1, October 12, 2016): U.S. Geological Survey Scientific Investigations Report 2016–5058, 55 p., http://dx.doi.org/10.3133/sir20165058

CAPE COD CANAL HIGHWAY BRIDGES
BOURNE AND SANDWICH, MASSACHUSETTS
MAJOR REHABILITATION EVALUATION REPORT

APPENDIX A
ENGINEERING RELIABILITY ANALYSIS

This Page Intentionally Left Blank

Appendix A
Table of Contents

1. PURPOSE A-1

2. PROJECT OVERVIEW A-1
   a. Description – Bourne Bridge A-1
   b. Maintenance History – Bourne Bridge A-3
   c. Description – Sagamore Bridge A-4
   d. Maintenance History – Sagamore Bridge A-6

3. FACTORS DEFINING THE NEED FOR REHABILITATION OR REPLACEMENT A-8
   a. Structurally Deficient & Functionally Obsolete Criteria A-8
   b. Overview of National Bridge Inspection Program & Condition Ratings A-9

4. PRESENT CONDITION OF BRIDGES A-11
   a. Bourne Bridge Condition (2016) A-11
   b. Sagamore Bridge Condition (2017) A-16

5. FATIGUE ANALYSIS SUMMARY A-19
   a. Section Properties A-19
   b. AASHTO Stress Categories A-20
   c. Truss Members A-20
   d. Stringers A-21
   e. Floorbeams A-22
   f. Traffic A-22
   g. Live Load A-22
   h. Infinite Life Check A-22
   i. Estimating Finite Fatigue Life A-22
   j. Fatigue Summary A-23

6. CORROSION ANALYSIS SUMMARY A-23
   a. Rate of Corrosion A-23
   b. Corrosion Results A-26
   c. Corrosion Summary A-34

7. ALTERNATIVES A-34
   a. Base Condition A-34
   b. Major Rehabilitation A-35
   c. Bridge Replacement A-41

Table of Contents (continued)

8. STRUCTURAL RELIABILITY A-43
   - a. Objective A-43
   - b. Economic Alternative A-43
   - c. Reliability Concepts A-43
   - d. Deterioration Models A-44
   - e. Reliability Calculations for the Base Condition A-47
   - f. Reliability Calculations for Major Rehabilitation & Bridge Replacement Alternatives A-47
   - g. Consequences of Unsatisfactory Performance A-47
   - h. Results of Reliability Analysis A-48
   - j. Structural Conclusion A-49

9. REFERENCES A-63

ATTACHMENT A – Drawings and Photographs

Bourne and Sagamore Bridge Drawings A-64

Photographs – Bourne Bridge A-75

Photographs – Sagamore Bridge A-83

APPENDIX A

ENGINEERING RELIABILITY ANALYSIS

1. PURPOSE

This appendix contains an engineering analysis which demonstrates the criticality and reliability of key elements of the Bourne and Sagamore bridges. The results of this analysis form the basis for the economic evaluation of the base condition versus alternative schemes for repair or replacement.

2. PROJECT OVERVIEW

a. Description – Bourne Bridge

The Bourne Bridge is one of three Cape Cod Canal crossings and carries vehicular and pedestrian traffic on State Route 28 across the Cape Cod Canal, Sandwich Road and the Massachusetts Coastal Railroad. There are two vehicular bridges, the Bourne and Sagamore, and one railroad bridge. Figures A-1 through A-11 exhibit the various features and bridge components discussed in this appendix.

The Bourne Bridge, constructed in 1933 under the direction of the United States Army Corps of Engineers, is a seven span bridge with four approach spans and three main spans. Spans are labeled 7, 5, 3, 1, 2, 4 and 6 from south to north with the main center span designated span 1, the main side spans designated span 3 to the south and span 2 to the north, and the approach spans alternating with even number designations to the north and odd number designations to the south. Piers are labeled 5, 3, 1, 2, 4 and 6 from south to north with piers 1 and 2 located at either shore of the channel.

The total length of the bridge is 2,684 feet. The main spans of the Bourne Bridge, spans 3, 1 and 2, are composed of steel trusses forming three continuous spans. Span 1 extends over the Cape Cod Canal, is 616 feet in length, and provides a vertical clearance of 135 feet above mean high water. Span 1 is a through arch truss suspended span with 22 galvanized strand suspender cables, 11 on each truss, to suspend the roadway deck and floor system. The two side spans, each 396 feet in length, are deck trusses that transition over piers 1 and 2 into span 1.

The four approach spans are simply supported deck trusses ranging in length from 208 feet to 270 feet with spans 4 and 6 to the north of the canal and spans 5 and 7 to the south of the canal. The bridge approaches consist of a 150 foot long multi-chamber abutment at each end.

The roadway is composed of four 10'-0" wide lanes with a 6'-8" wide sidewalk along the west fascia and a 2'-0" brush curb along the east fascia.

The overall configuration of the Bourne Bridge means it a “fracture critical” bridge. It has non-redundant steel tension members, primarily the trusses, which defines this bridge as fracture critical.

i) Superstructure

The approach span trusses (spans 7, 5, 4 and 6) and main side span trusses (spans 3 and 2) vary in depth from 22 feet to 45 feet, as measured from the centerline of the bottom chord to the centerline of the top chord. The main center span arch truss (span 1) varies in depth from 50 feet to 93 feet.

The approach span trusses have eight panels each with truss joints labeled 0 to 8 from south to north. Truss panels are 30'-0" long in span 7; 30'-9" long in span 5; 30'-0" long in span 4; and 26'-0" long in span 6.

The main side span trusses have nine panels each and the main center span arch truss has 14 panels with all panels 44'-0" long. Truss joints in these three spans are labeled symmetrically about the midspan of span 1 at joint 16 with the joints to the north differentiated with a “prime” designation. From south to north, these truss joints are designated 0 to 9 in span 3; 9 to 16, then 15' to 9' in span 1; and 9' to 0' from south to north in span 2.

The truss floor system is composed of sixty-nine 5'-0" deep floorbeams located at each truss joint in each truss span. Nine stringers and three support channels span between the floorbeams and support the roadway deck, sidewalk and brush curb. The stringers are spaced 5'-0" on center. The floorbeam ends are connected at the trusses, with the exception of the 11 center floorbeams in span 1 which are supported at each end by a pair of galvanized strand suspender cables for a total of 44 individual suspender cables.

ii) Abutments

The abutments are hollow cell concrete structures each composed of three chambers. Within the abutments are concrete bents or transverse chamber walls forming bays ranging in length from 28'-1" to 30'-6". The bents and chamber walls support six reinforced concrete T-beams spaced 7'-0" on center.

iii) Piers

The two channel piers, piers 1 and 2, each consist of two columns that share a common 25'-0" deep footing with the columns set on individual pedestals. The top of the pedestals for each column, above the top of the footing, is 34'-0" and 27'-0" for piers 1 and 2, respectively. The upper 14'-0" of the pedestal is clad with a granite stone facing with a depth of stone into the footing of 2 feet to 3 feet. The hollow concrete columns are 24'-0" by 24'-0" at the base and 15'-0" by 15'-0" at the bearing level and are joined at the top by a tapered strut that has a minimum depth of 23'-0" located at the midspan of the strut. The distance from the top of the columns to the top of footings is 111'-0" and 104'-0" for piers 1 and 2, respectively.

Piers 5, 3, 4, and 6 consist of two solid concrete columns that share a common 13'-0" deep footing. Only pier 6 has columns founded on individual pedestals while the remaining piers have the columns founded directly onto the footing. For pier 6, the top of each pedestal is 7'-0" above the top of the footing. The solid concrete columns are 20'-0" by 20'-0" at the base and 14'-0" by 14'-0" at the bearing level at piers 3 and 4. For piers 5 and 6, the solid concrete columns are 18'-0" by 18'-0" at the base and 12'-0" by 12'-0" at the bearing level. All four piers have their columns joined at the top by a tapered strut that has a minimum depth of 16'-0" located at the midspan of the strut. The distance from the top of the columns to the top of the footings is 54'-6" for pier 5, 60'-0" for piers 3 and 4 and 63'-0" for pier 6.

iv) Deck

The deck on the truss spans is a steel grid deck filled with 5" of lightweight concrete. The wearing surface is 2" thick bituminous concrete (Rosphalt). The underside of the deck is hidden by stay-in-place forms. The deck within the abutment spans is 9" thick reinforced concrete.

b. Maintenance History – Bourne Bridge

Table 1 below summarizes the maintenance and repair history of the Bourne Bridge.

Table A-1 Bourne Bridge Maintenance and Repair History

YEAR	WORK PERFORMED
1938	Painted superstructure.
1938	Sealed coated wearing surface - sheet asphalt.
1947	Painted superstructure.
1949	Replaced bituminous pavement.
1952	Painted superstructure.
1958	Painted superstructure.
1959	Replaced 4 anchor bolts (Piers 3 and 5).
1963	Resurfaced roadway and sidewalk; new curbing; new scuppers; replaced 5’ strip of deck concrete adjacent to the sidewalk and the brush curb; electrical work; concrete repairs; access ladders; platforms and downspouts.
1967	Painted superstructure.
1969	Pressure grouting of cracks in concrete abutments and piers.
1971	Painted railings.
1973	Painted superstructure.
1976	Repaired two stringers, Span 4; replaced sidewalk bracket, Span 1, removed bird droppings from abutments; removed two pairs of hanger cables for testing and replaced with new cables.
1979	Removed existing deck and replaced with lightweight concrete filled steel grid deck; installed new waterproofing membrane and bituminous wearing surface; strengthened upper and lower bracing in Spans 4 to 7; repaired over 250 members; repaired or replaced over 200 gusset/stay plates; replaced approximately 3000 deteriorated rivets with high strength bolts; installed new roadway joints; and painted superstructure.
1984	Placed new waterproofing membrane on sidewalk and curb.

Table A-1 Cont. - Bourne Bridge Maintenance and Repair History	
YEAR	**WORK PERFORMED**
1986	New hanger cables installed; new drainage pipes installed; new waterproofing on curb; patched spalls and injected cracks on abutments, piers, and parapets; electrical work; painted superstructure.
1988	Removed existing bituminous waterproofing membrane and top 1-1/2 inch of deck concrete on abutments; placed new 1-1/2 inch micro-silica overlay; new waterproofing membrane and bituminous concrete wearing surface.
1992	Painted superstructure.
1997	Repaired/replaced deck joints at South Abutment, Pier 3 and North Abutment.
1999	Replaced deck joint at Pier 4; major concrete repairs to abutments and piers.
2000	Replaced concrete parapets; repaired sidewalk and curbs; replaced waterproofing membrane and bituminous wearing surface on deck and abutments; miscellaneous electrical work.
2001	Major substructure rehabilitation including: concrete spall repairs to piers, abutment seats, abutment chamber walls and bents and concrete stringer repairs within chambers.
2004	Painted superstructure with work completed in 2006.
2010	Deck rehabilitation contract performed. Removed the existing asphalt pavement and waterproofing membrane on both abutments and the steel superstructure deck; repaired concrete substrate on abutments; repaved entire length of bridge with Rosphalt.
2012	Steel repairs throughout the entire length of the bridge including gusset plate patch plates, replacement of sway bracing, replacement of missing rivets with bolts at member connections and lacing bar connection, removal of fatigue sensitive weld details on truss members, floorbeams and stringers and replacement of deck drainage support brackets with new drainage downspouts. $6.8 million (combined with Sagamore Bridge Steel Repairs – Total $9.7 million).

c. Description – Sagamore Bridge

The Sagamore Bridge is one of three Cape Cod Canal crossings and carries vehicular and pedestrian traffic on State Route 6 across the Cape Cod Canal, Sandwich Road and the Massachusetts Coastal Railroad. The Sagamore Bridge, completed in 1935 under the direction of the United States Army Corps of Engineers, is a three span bridge. Spans are labeled 3, 1 and 2 from south to north with the main span designated span 1, and the side spans designated span 3 to the south and span 2 to the north. Piers are labeled 1 and 2 from south to north with piers 1 and 2 located at either side of the canal.

The total length of the bridge including the abutment spans is 1,833 feet. The main spans of the Sagamore Bridge, spans 3, 1 and 2, are composed of steel trusses forming three continuous spans for a total length of 1,408 feet. Span 1 extends over the Cape Cod Canal, is 616 feet in length, and provides a vertical clearance of 135 feet above the navigation channel at mean high water. Span 1 is a through arch truss suspended span with 22 galvanized strand suspender cables, 11 on each truss, to suspend the roadway deck and floor system. The two side spans, each 396 feet in length, are deck trusses that transition over piers 1 and 2 into span 1.

The bridge approaches consist of a 225 foot long reinforced concrete multi-chamber abutment at the south end and a 200 foot long reinforced concrete multi-chamber abutment at the north end.

The roadway is composed of four 10'-0" wide lanes, two in each direction with a 6'-8" wide sidewalk along the east fascia and a 2'-0" brush curb along the west fascia.

A system of ladders, platforms and catwalks provides inspection and maintenance access from inside of each abutment to the bridge seats, the floor system throughout the full length of the bridge and the pier caps. A separate system of ladders, platforms and catwalks provides access along the east truss lower chord above the roadway from truss joint L11' to L16, the east truss lower chord to the upper chord at truss joint 16 and the east truss upper chord to the west truss upper chord at U16.

The overall configuration of the Sagamore Bridge means it a “fracture critical” bridge. It has non-redundant steel tension members, primarily the trusses, which defines this bridge as fracture critical.

i) Superstructure

The main side span trusses (spans 3 and 2) vary in depth from 44'-9" to 93'-0", as measured from the centerline of the bottom chord to the centerline of the top chord. The main center span arch truss (span 1) varies in depth from 50 feet to 93 feet.

The side span trusses have nine panels each and the center span arch truss has 14 panels with all panels 44'-0" long. Truss joints in these three spans are labeled symmetrically about midspan of span 1 at joint 16 with the joints to the north differentiated with a “prime” designation. From south to north, these truss joints are designated 0 to 9 in span 3; 9 to 16, then 15' to 9' in span 1; and 9' to 0' from south to north in span 2.

The truss floor system is composed of thirty-three 5'-0" deep floorbeams located at each truss joint in each truss span. Nine stringers and three support channels span between the floorbeams and support the roadway deck, sidewalk and brush curb. The stringers are spaced 5'-0" on center. The floorbeam ends are connected at the trusses, with the exception of the 11 center floorbeams in span 1 which are supported at each end by a pair of galvanized steel strand suspender cables for a total of 44 individual suspender cables.

ii) Abutments

The abutments are hollow cell concrete structures each composed of four chambers. Within the abutments are concrete bents or transverse chamber walls forming bays ranging in length from 26'-10" to 31'-4". The bents and chamber walls support six reinforced concrete T-beams spaced 7'-0" on center. Chamber 3 of the south abutment spans over Sandwich Road and has an additional concrete slab above Sandwich Road and below the bridge deck which is supported by two T-beams and acts as a floor for the interior of chamber 3.

iii) Piers

The two channel piers, Piers 1 and 2, consist of two columns that share a common 25'-0″ deep footing with the columns set on individual pedestals. The top of each pedestal is 37'-0″ above the top of footing. The upper 16'-0″ of the pedestals is clad with stacked granite stone facing with a depth of stone into the footing of 2 feet to 3 feet. The hollow concrete columns are 24'-0″ by 24'-0″ at the base and 15'-0″ by 15'-0″ at the bearing level and are joined by a tapered strut that has a minimum depth of 23'-0″ located at the midspan of the strut. The top of each column is 114'-6″ above the top of footing.

iv) Deck

The deck on the truss spans is a steel grid deck filled with 5" of lightweight concrete. The wearing surface is 2" thick bituminous concrete (Rosphalt). The underside of the deck is hidden by stay-in-place forms. The deck within the abutment spans is 9" thick reinforced concrete.

d. Maintenance History – Sagamore Bridge

Table 2 below summarizes the maintenance and repair history of the Sagamore Bridge.

Table A-2 - Sagamore Bridge Maintenance and Repair History

YEAR	WORK PERFORMED
1938	Paint superstructure.
1938	Seal coat wearing surface - sheet asphalt.
1942	Paint railings.
1947	Paint superstructure.
1952	Paint superstructure.
1955	Replace bituminous pavement.
1959	Replace roller nest at north abutment.
1962	Resurface roadway and sidewalk; new curbing; repair expansion joints; replace 5- foot strips of deck concrete adjacent to curbs; concrete repairs; new scuppers; electrical work.
1963	Paint superstructure. Additional access ladders and platforms, downspouts added to scuppers, repairs to catwalk under deck, replace railing bolts.
1964	10" Welded steel gas main installed beneath deck from abutment to abutment.
1969	Rehabilitate sidewalk and curb; repair substructure cracks.
1970	Door Repair.

Table 2 Cont. - Sagamore Bridge Maintenance and Repair History

1970	Paint Superstructure.
1974	Repair structural members, concrete, expansion joints, railings; miscellaneous work.
1975	Hanger Cable Replacement.
1976	Joint repair at expansion joint on south abutment.
1981	Remove existing deck and replace with lightweight concrete filled steel grid on galvanized steel stay-in-place forms; add new preformed waterproofing membrane and bituminous concrete wearing surface; new concrete sidewalks and curbs; repair or replace approximately 200 steel gusset/stay plates; replace approximately 1,000 lacing bars; replace approximately 1,000 deteriorated rivets with new high strength bolts; place new deck joints; replace hanger cables; install suicide deterring fence; paint superstructure.
1982	Door Replacement.
1986	Patch spalls and inject cracks on abutments, piers and parapets.
1987	Remove existing bituminous pavements, waterproofing membrane, and upper 1 1/2" of concrete from abutment deck surface; place new 3 1/2" microsilica concrete overlay and wearing surface.
1990	Paint Superstructure.
1996	Replace deck joint between south abutment and Span 3 with modular type expansion joint.
1997	Replace deck joint between north abutment and Span 2 with modular type expansion joint.
1999	Paint superstructure.
2000	Repair concrete abutments and piers; replace deteriorated catwalk grating.
2007	Replaced modular joint between South Abutment and Span 3.
2008	Minor maintenance repairs to catwalk.
2010	Installation of new bearing anchor bolt covers at both abutments.
2010	Repaving of full width roadway (Rosphalt) and resurfacing of sidewalk for Spans 1, 2 and 3 as well as for full length of both abutments. Replaced sidewalks and parapets on both abutments.
2012	Steel repairs throughout the entire length of the bridge including gusset plate patch plates, repairs to lateral bracing and sway bracing and their connections, replacement of missing rivets with bolts at member connections and lacing bar connection, removal of fatigue sensitive weld details on truss members, floorbeams and stringers and replacement of deck drainage support brackets with new drainage downspouts. $2.9 million (combined with Bourne Bridge Steel Repairs – Total $9.7 million)
2014	Painted superstructure. Currently ongoing; work to be completed in 2014. $13.0
2018	Replaced modular joint system & all supporting concrete at south abutment joint; replaced all compression seal joints. $1.7 million

3. FACTORS DEFINING THE NEED FOR REHABILITATION OR REPLACEMENT

The overall condition of both the Bourne and Sagamore bridges is becoming worse as the bridges age and major maintenance projects becomes more frequent. As the condition deteriorates, this leads to the bridges becoming structurally deficient. B oth bridges are functionally obsolete and are routinely unable to provide an efficient flow of traffic in conjunction with the current State and local roadway network leading to the bridge approaches.

a. Structurally Deficient & Functionally Obsolete Criteria

Bridges are considered “structurally deficient” if significant load-carrying elements are found to be in poor or worse condition due to deterioration and/or damage. A “deficient” bridge typically requires maintenance and repair and eventual rehabilitation or replacement to address deficiencies. To remain open to traffic, structurally deficient bridges are often posted with reduced weight limits that restrict the gross weight of vehicles using the bridges. If unsafe conditions are identified during a physical inspection, the structure could be closed.

Bridges are considered functionally obsolete when the geometry of the roadway no longer meets today’s minimum design standards for either width or vertical clearance for that roadway classification. A functionally obsolete bridge is one that was built to standards that are not used today. Functionally obsolete bridges are those that do not have adequate lane widths, shoulder widths, or vertical clearances to serve current traffic demand, or those that may be occasionally flooded.

Note, the Federal Highway Administration (FHWA) no longer uses the term “functionally obsolete” to define bridges, however, USACE is using this term for historical context within the framework of the Major Rehab study.

The criteria for defining a “structurally deficient” bridge includes when the condition rating for various bridge elements is considered poor. These bridge elements include the deck, superstructure, or substructure. Any one of these considered to be in poor condition leads to a designation of “structurally deficient”.

The previous criteria for defining a “functionally obsolete” bridge includes things such as the deck geometry and approach roadway configurations. Again, while this term is no longer used by FHWA, it is used within this report as a means of identifying obsolete design parameters.

The definitions associated with the terms “structurally deficient” and “functionally obsolete” are based on specific coding of various items in the bridge inventory database for each bridge.

The Bourne Bridge is currently structurally deficient, while the Sagamore Bridge has been historically found to be deficient multiple times in the past. These deficiencies are because certain bridge elements were considered to be in poor condition, based on the condition ratings provided during the inspections of the bridges, as explained in paragraph “4. PRESENT CONDITION OF BRIDGES”. Both the Bourne and Sagamore bridges are considered functionally obsolete.

b. Overview Of National Bridge Inspection Program & Condition Ratings

The Bourne and Sagamore Bridges are inspected every 24 months according to the current National Bridge Inspection Standards (NBIS). The NBIS sets the national standards for the proper safety inspection and evaluation of all highway bridges in accordance with 23 U.S.C. 151.

These standards define the organizational responsibilities, qualifications, inspection frequency, procedures, and bridge inventory reporting requirements. The NBIS regulations apply to all publicly owned highway bridges longer than twenty feet located on public roads.

The primary purpose of the NBIS is to locate and evaluate existing bridge deficiencies to ensure the safety of the traveling public. To provide further guidance, the Federal Highway Administration (FHWA) publishes the *Recording and Coding Guide for the Structure Inventory and Appraisal of the Nation's Bridges*.

The coding guide has been prepared for use in recording and coding the data elements that comprise the National Bridge Inventory (NBI) database. Bridge inspections consist of applying condition ratings to the various bridge components. The coding guide outlines the specific bridge components that are required to be inspected and provides the guidelines on how to apply condition ratings.

Condition ratings are assigned on a scale of 0–9 to the individual components by bridge inspectors using the guidelines established by the FHWA in the coding guide. See Table A-3 - National Bridge Inventory Condition Ratings (FHWA-HIF-11042, Bridge Preservation Guide: Maintaining a State of Good Repair using Cost Effective Investment Strategies, August 2011).

The "Condition Rating" codes for each bridge are obtained from Table A-3 based on the most recent physical inspection of the bridge.

In order to promote uniformity between bridge inspectors, these guidelines are used to rate and code Items 58 (Deck), 59 (Superstructure), and 60 (Substructure). Condition ratings are used to describe the existing, in-place bridge as compared to the as-built condition and to determine structural deficiency ~~and functional obsolescence~~. Evaluation is for the materials and physical condition of the deck, superstructure, and substructure components of a bridge.

It is important to understand that condition codes are properly used when they provide an overall characterization of the general condition of the entire component being rated ("Recording and Coding Guide for the Structure Inventory and Appraisal of the Nation's Bridges", Report No. FHWA-PD-96-001, December 1995.)

Table A-3 - National Bridge Inventory Condition Ratings

Code	Description	Commonly Employed Feasible Actions
9	EXCELLENT CONDITION	Preventive Maintenance
8	VERY GOOD CONDITION No problems noted.	
7	GOOD CONDITION Some minor problems.	
6	SATISFACTORY CONDITION Structural elements show some minor deterioration.	Preventive Maintenance; and/or Repairs
5	FAIR CONDITION All primary structural elements are sound but may have some minor section loss, cracking, spalling or scour.	
4	POOR CONDITION Advanced section loss, deterioration, spalling or scour.	Rehabilitation or Replacement
3	SERIOUS CONDITION Loss of section, deterioration, spalling or scour have seriously affected primary structural components. Local failures are possible. Fatigue cracks in steel or shear cracks in concrete may be present.	
2	CRITICAL CONDITION Advanced deterioration of primary structural elements. Fatigue cracks in steel or shear cracks in concrete may be present or scour may have removed substructure support. Unless closely monitored the bridge may have to be closed until corrective action is taken.	
1	IMMINENT FAILURE CONDITION Major deterioration or section loss present in critical structural components or obvious vertical or horizontal movement affecting structure stability. Bridge is closed to traffic but corrective action may put back in light service.	
0	FAILED CONDITION Out of service - beyond corrective action.	

4. PRESENT CONDITION OF BRIDGES

a. Bourne Bridge Condition (2016)

The Bourne Bridge is both structurally deficient and functionally obsolete.

The deck (Item 58) is in fair condition with a condition rating of 5. The superstructure (Item 59) is in poor condition with a condition rating of 4, and the substructure (Item 60) is in good condition with a condition rating of 7. A history of these condition ratings is shown in Figure A-4-1 at the end of this section.

The condition of the deck was downgraded from a previous inspection in 2012 from good to fair due to continuing deterioration of the deck in the abutment spans. Despite recent steel repairs and the removal of fatigue sensitive detail welds, the superstructure remains in poor condition due to continuing deterioration of truss joint gusset plates. The substructure remains in good condition. The most significant inspection findings from the 2016 Routine Inspection that warrant condition codings of fair for the deck, poor for the superstructure and good for the substructure are as follows:

- ***Deteriorated area of deck over the abutments*** - There is a 2'-6" wide by 4'-4" long area of the top of deck in the right southbound lane adjacent to the northern deck joint of the north abutment with full depth spalling of the wearing surface which exposes a similar sized area of sound alligator cracked deck (see Photo 1). The underside of the deck and T-beam below this area exhibit heavy efflorescence and active water leaking during rain. There are four locations in the southbound lane over the south abutment which exhibit the beginning signs of similar conditions.
- ***Deteriorated deck joints*** – The pier 5 deck joint compression seal is dislodged throughout the width of the northbound lanes. The western 6'-0" of the Transflex deck joint at pier 3 (see Photo 2) is loose with up to 1 1/4" gaps at the anchor nuts and up to 1/2" of deflection and bouncing under live load. The modular deck joint at pier 4 exhibits misalignment between the south edge beam and the adjacent center beam in the right southbound lane with the seal between these two beams partially dislodged for a length of 6'-0". Lastly, the pier 6 deck joint compression seal is dislodged and missing across the full width of the roadway (see Photo 3).
- ***Unrepaired gusset plates with significant section loss*** **-** There are unrepaired gusset plates at eighteen truss joints that continue to exhibit areas of significant section loss and/or deformation due to pack rust in all spans on both trusses. This includes the following locations:

  West Truss

  - Span 2: The east gusset plate at truss joint L5' exhibits up to 1/2" thick pack rust along the south edge of the truss vertical member with slight deforming of the gusset plate.
  - Span 2: The gusset plates at truss joints U0', U2' and U4' exhibit pack rust with section loss to the exterior gusset plate along the edges of the truss vertical member with deformation of the gusset plate. The exterior gusset plate at truss joint U6' exhibits heavy section loss along the interface with the sidewalk channel. The interior gusset plate at

truss joint L7' exhibits heavy section loss along the top of the lower chord member (see Photo 4).

- Span 3: The exterior gusset plates at truss joints U0 and U2 exhibit pack rust with section loss along the edges of the truss vertical member with deformation of the gusset plate (see Photo 5). The exterior gusset plate at truss joint U1 exhibits heavy section loss along the top edge of the vertical member. The exterior gusset plate at truss joint U6 exhibits heavy section loss along the interface with the sidewalk channel.
- Span 5: The gusset plates at truss joint L7 exhibit heavy section loss along the top of the lower chord member and surrounding the vertical member.
- Span 4: The gusset plates at truss joint L5 exhibit heavy section loss along the full height of both gusset plates along both edges of the truss vertical member.
- Span 6: The gusset plates at truss joint L7 exhibit heavy section loss along the top of the lower chord member.

East Truss

- Span 2: The exterior gusset plate at truss joint U0' exhibits pack rust with section loss along the edges of the truss vertical member with deformation of the gusset plate. The exterior gusset plate at truss joint U6' exhibits heavy section loss along the interface with the sidewalk channel.
- Span 3: The exterior gusset plate at truss joint U0 exhibits pack rust with section loss along the edges of the truss vertical member with deformation of the gusset plate. The exterior gusset plate at truss joint U6 exhibits heavy section loss along the interface with the sidewalk channel (see Photo 6).
- Span 6: The gusset plates at truss joint L3 exhibit heavy section loss along the top of the lower chord member and surrounding the vertical member.

♦ ***Fatigue sensitive details (FSD's) on fracture critical members (FCM's)*** – There are numerous FSD's on FCM's in the form of welded attachments (see Photo 7), weld remnants from removed attachments, weld strikes, cuts in the base metal at locations of removed welds and incomplete weld removal with jagged edges or weld undercutting remaining in the base metal.

♦ ***Fatigue sensitive details on stringers*** – There are cuts in the bottom flanges of stringer S4 between floorbeams FB14' and FB15' and stringer S4 between floorbeams FB15' and FB16' in span 1 due to improper weld removal. There are two locations of remnant welds from removed attachments to stringer S4 between floorbeams FB0' and FB1' in span 2.

♦ ***Deteriorated and partially undermined concrete T-beams*** – Beam BM1 is heavily deteriorated in chamber 1 of the south abutment and in chambers 1, 2 and 3 of the north abutment. Previously noted areas of cracks and delaminations to patched areas of beam BM1 in chamber 1 of the south abutment have spalled to the depth of the concrete cover exposing the lower mat of the reinforcing bars which is heavily rusted and exhibits up to 1/8" section loss to the underside of the bars. Beam BM1 in chamber 1 of the north abutment between the north wall and the intermediate strut exhibits longitudinal hairline cracks on the underside with active water infiltration during rain, a minor spall on the underside and heavy efflorescence on the west face. Beam BM1 in chamber 2 of the north abutment exhibits a full length longitudinal crack along the underside of the beam following the construction joint of a repair where the beam had been widened. In addition, the west face of the widened portion of the beam is delaminated. Beam BM1 in chamber 3 of the north abutment exhibits longitudinal hairline cracks with efflorescence and rust staining in an area where the discharge from a drainage scupper splashes directly on the T-beam. The load bearing area of Beams BM1 and BM3 in chamber 2 of the south abutment are partially undermined (see Photo 8).

- ***Spalled and delaminated abutment walls*** – There are two spalls in the north wall of chamber 2 in the south abutment which partially undermine the bearing area for beams BM1 and BM3, and an additional area of delaminated concrete beneath beam BM5. The south wall of chamber 2 in the north abutment exhibits a similar spall and delamination adjacent to and beneath beam BM3.

Some additional general inspection findings are as follows (see Photos 9 through 16):

The main truss members, as well as floorbeams below deck joints, exhibit pack rust between the riveted built-up component elements. There is associated plate warping and localized section loss on individual components such as lacing bars and batten plates for truss members and web stiffeners and flange plates for floorbeams. The fascia stringers also exhibit localized section loss and some pack rust between their connection angles and the stringer webs. The section loss exhibited by the main truss members, floorbeams and stringers is in the form of pitting that is typically 1/8" deep. As a result of the repainting project that began in 2004 and was completed in 2006, much of the corrosion that was previously noted in past inspection cycles has been arrested and is no longer active.

The suspender cables are in fair condition. The suspender cables are assessed using standard criteria presented in section 1.4.2.2. of the Transportation Research Board's National Cooperative Highway Research Program (NCHRP) Report 534. Several suspender cables exhibiting Stage III corrosion and Stage IV corrosion on the outer wires. Stage III is when the zinc coating at the location of ferrous corrosion is typically almost completely consumed. Random wire cracking is possible during this stage. Stage IV is when the wire surface is generally rough and pitted in these areas and wire section loss such as necking as well as wire cracks and breaks are possible at this stage. The suspenders exhibit small areas of corrosion, up to stage III, on thirteen suspenders and stage IV corrosion on five suspenders, an increase of five additional affected suspenders from the 2012 inspection.

Overall the paint system on the Bourne Bridge is in fair condition; however, numerous localized deficiencies were observed during the 2014 inspection including paint adhesion failure, blasting grit debris left on members throughout the bridge, and areas that were not painted. There are also numerous localized areas of the paint system failure such as full width of the faces of the floorbeams directly below roadway joints; the bearings and truss members and their connections below roadway joints; the stringer ends at the deck joints at truss joints 10 and 10'; and the fascia side of the stringers. The suspender cables were noted to be painted, but their paint condition was poor with several suspender cables exhibiting incomplete painting, residual rusted blasting debris within the wires, as well as around the base of the lower socket, and scrapes along the suspender cables that have damaged the galvanizing system and, therefore, made these elements much more susceptible to corrosion.

The bridge traffic safety features, including the bridge railing, transitions, approach guardrails and approach guardrail ends, do not conform to current AASHTO or MassDOT Specifications. In general, these features are composed of nonstandard configurations and do not conform to current MassDOT standards. Additionally, there are areas with no positive connections at the transitions between approach guardrails and the concrete end posts, and some of the W-beam approach guardrails do not conform to current MassDOT standards. These elements are thus rated as not meeting currently accepted standards.There are no scour issues associated with either pier in the water at the edge of the Canal.

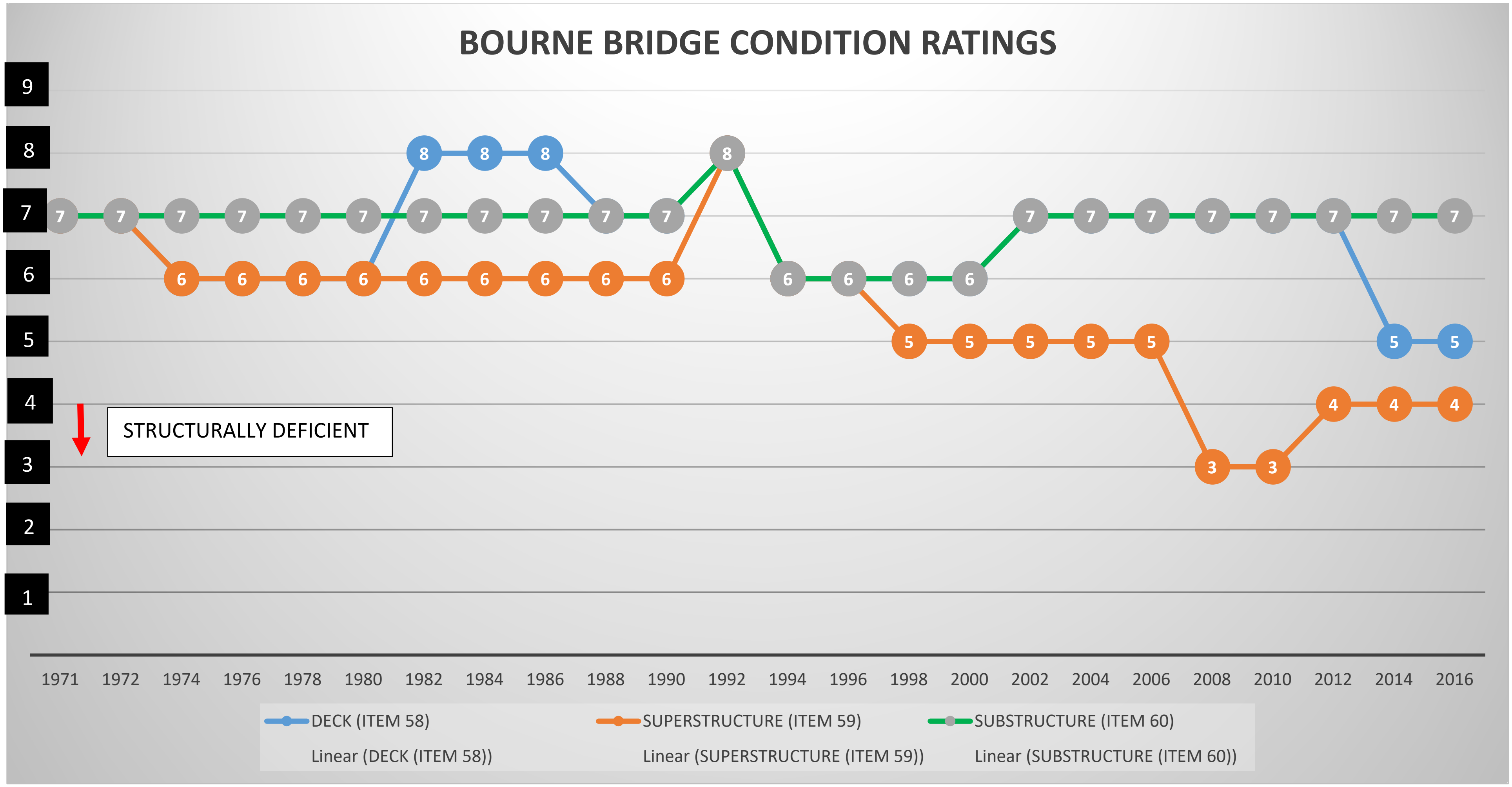


Figure A-4-1: Bourne Bridge History of Condition Ratings

b. Sagamore Bridge Condition (2017)

The Sagamore Bridge is functionally obsolete and has been structurally deficient in the past as recently as 2011. The deck (Item 58), superstructure (Item 59), and substructure (Item 60) are all currently in fair condition with condition ratings of 5. The overall condition of the Sagamore Bridge has not changed since the previous inspection. However, there are individual components that warrant condition ratings of “poor”, for example, the gusset plates and other connection plates.

A history of these condition ratings is shown in Figure A-4-2 at the end of this section.

The most significant inspection findings that warrant condition codings of fair for the deck, superstructure and substructure are as follows:

- ***Deteriorated deck along the reinforced concrete deck joint headers*** – Widespread delaminations with localized deep spalls, exposed rebars, and debonded reinforcing in the concrete deck joint headers for the modular deck joints (see Photo 17) located between each abutment and the truss spans. There is vertical misalignment resulting in an uneven riding surface and heavy vehicle impact to span 3 when traveling north. The south modular joint was replaced in 2018.
- ***Deteriorated truss span deck along exterior stringers*** – Shallow spalling of the reinforced concrete in areas where previously deteriorated stay-in-place forms had been removed and the exposed concrete painted.
- ***Deteriorated abutment span deck*** – Widespread hairline map cracking with efflorescence in the underside of the deck throughout all abutment chambers (see Photo 18).
- ***Gusset plates with significant section loss*** **-** There are gusset plates at twenty-five truss joints that continue to exhibit areas of significant section loss and/or deformation due to pack rust as follows:

  East Truss

  - Span 3: The gusset plates at truss joints U0, U2 and U4 exhibit pack rust with section loss along the edges of the exterior gusset plate with deformation of the gusset plate. The interior gusset plate at L7 exhibits heavy section loss along the top of the lower chord member (see Photo 19).
  - Span 2: The gusset plates at truss joints U0', U2' and U4' exhibit pack rust with section loss along the edges of the exterior gusset plate with deformation of the gusset plate (see Photo 20). The interior gusset plates at U6', L1', L3', and L7' all exhibit heavy section loss and deformation.

  West Truss

  - Span 3: The exterior gusset plates at truss joint U0 and U2 exhibit pack rust with section loss along the edges and deformation of the gusset plate (see Photo 21).
  - Span 1: The south edge of the interior gusset plate at truss joint U11 is bowed 1/4".
  - Span 2: The gusset plates at truss joints U0', L1', U2' and U4' exhibit pack rust with section loss to the exterior gusset plate with deformation of the gusset plate. The interior

gusset plate at U6' exhibits heavy section loss along the interface with the sidewalk channel.

- ***Bearings at the south abutment*** – The south abutment bearings are both near the end of their thermal expansion range. The northwest anchor bolts of both bearings are bent 1/4" out of plumb and exhibit active corrosion (see Photo 22).
- ***Fatigue sensitive details (FSD's) on fracture critical members (FCM's)*** – There are numerous identified FSD's on FCM's in the form of welded attachments, weld remnants from removed attachments, cuts in the base metal at locations of removed welds and incomplete weld removal with jagged edges or weld undercutting remaining in the base metal (see Photo 23).
- ***Fatigue sensitive details on stringers*** –There are four locations of welded repair plates, welded connections and welded attachments to stringer bottom flanges which are considered fatigue sensitive.
- ***Deteriorated and partially undermined concrete T-beams*** – Beam BM4 in chamber 3 of the south abutment exhibits an area of deep scaling and honeycombing. The bearing areas of Beams BM1 and BM5 in chamber 1 of the south abutment and beam BM1 in chamber 1 of the north abutment are partially undermined due to spalling. Beam BM1 in chamber 1 of the north abutment exhibits scattered full width delaminations throughout the underside of the beam.
- ***Spalled and delaminated abutment walls*** – There is a horizontal crack with deep spalls and delaminations scattered along the length of the crack on exterior face of the south abutment just below the parapet and directly over the westbound lane of Sandwich Road, posing a falling debris hazard (see Photo 24). There are two deep spalls in the north wall of chamber 1 in the south abutment which partially undermine the bearing area for beams BM1 and BM5. There are areas of delaminated concrete patches beneath beams BM3 and BM6.

Some additional general inspection findings were as follows (see Photos 25 through 32):

The main truss members exhibit pack rust between the riveted built-up component elements. There is associated plate warping and localized section loss on individual components such as lacing bars and batten plates for truss members. The fascia stringers exhibit localized section loss and some pack rust between the floorbeam connection angles and the stringer webs. The floorbeams exhibit localized section loss to the web and flanges, particularly at the ends. The section loss exhibited by the main truss members, floorbeams and stringers is in the form of pitting that is typically 1/16" to 1/8" deep with localized areas of greater than typical section loss. As a result of the recent repainting project, a majority of the corrosion that was previously noted in past inspection cycles has been arrested and is no longer active.

The suspender cables are in fair condition with several suspender cables exhibiting localized areas of Stage III and Stage IV corrosion on the outer wires; however, these areas are isolated and do not result in any significant section loss.

There is vertical misalignment of the roadway between the south abutment span and span 3 which results in heavy impact, deflection and vibration of span 3 from vehicles travelling north. The drop off from the south abutment span to span 3 is so pronounced that vehicles often bottom out, resulting in scrapes in the wearing surface.

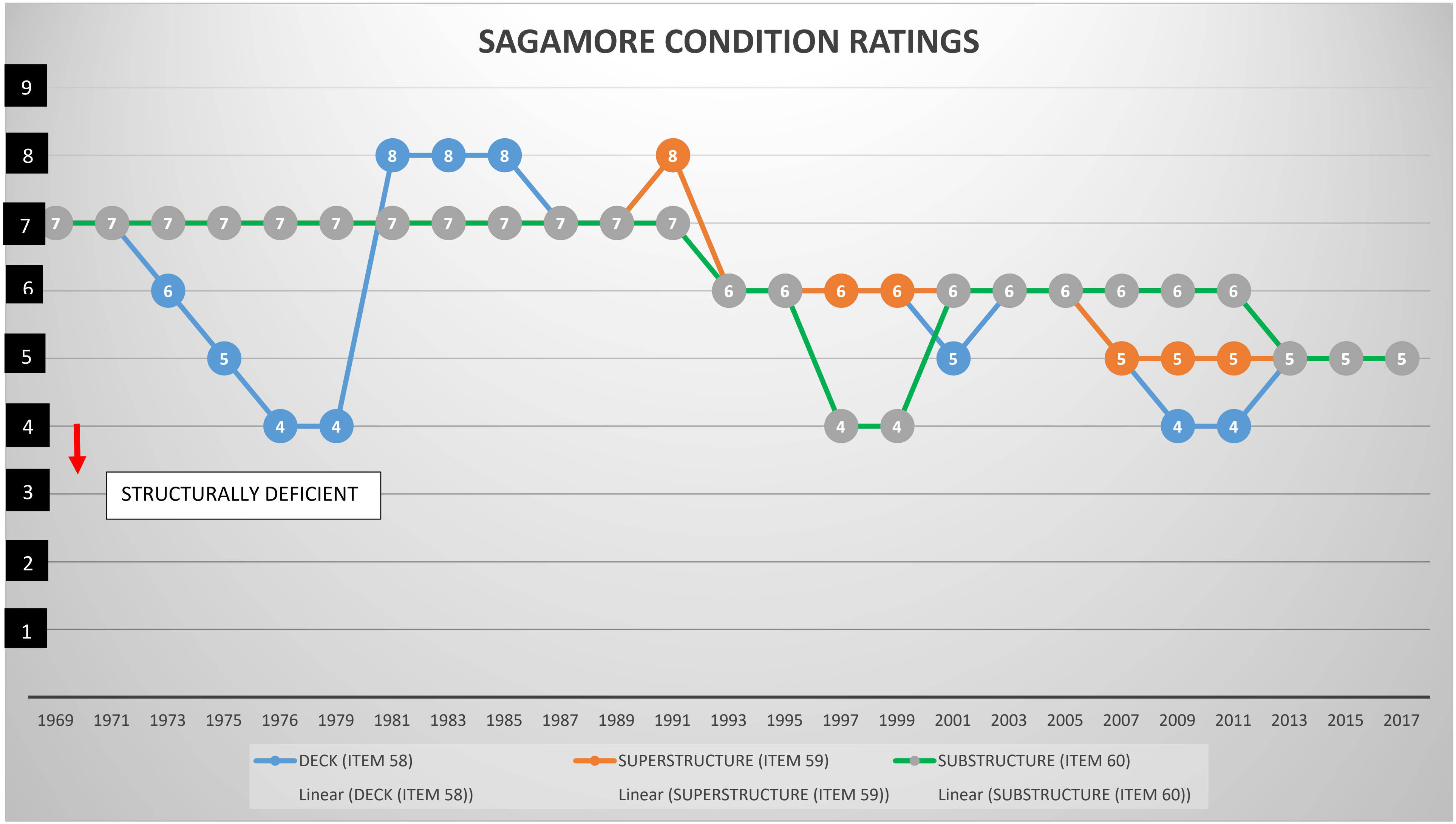


Figure A-4-2: Sagamore Bridge History of Condition Ratings

The bridge traffic safety features, including the bridge railing, transitions, approach guardrails and approach guardrail ends, do not conform to current AASHTO or MassDOT Specifications.

In general, these features are composed of nonstandard configurations and do not conform to current MassDOT standards. Additionally, there are areas with no positive connections at the transitions between approach guardrails and the concrete end posts, and some of the W-beam approach guardrails do not conform to current MassDOT standards. These elements are thus rated as not meeting currently accepted standards.

There are no scour issues associated with either pier in the water at the edge of the Canal.

5. FATIGUE ANALYSIS SUMMARY

As part of this Engineering Reliability Analysis, a load-induced fatigue analysis was conducted in accordance with current AASHTO standards and criteria (*LRFD Bridge Design Specifications* (LRFD) and the *Manual for Bridge Evaluation* (MBE)). The fatigue analysis was conducted for truss members, floorbeams, and stringers. The fatigue analysis results indicated that all primary load carrying members of the truss or flooring system (floorbeams, stringers, etc.) have an infinite fatigue life.

The force effect considered for the analysis consisted of the live load stress range. Only the live load plus dynamic load allowance was considered when computing the stress range cycle; permanent load did not contribute to the stress range.

The *Manual for Bridge Evaluation* states that “Bridges fabricated prior to the adoption of AASHTO’s *Guide Specifications for Fracture-Critical Non-redundant Steel Bridge Members* (1978) may have lower fracture toughness levels than are currently deemed acceptable.” Destructive material testing to ascertain actual toughness levels of the Bourne & Sagamore bridges has not been conducted. This would likely occur if a Major Rehabilitation of either bridge was found to be warranted.

The fatigue life of a steel bridge detail generally consists of crack initiation and stable crack propagation. The propagation stage continues until the crack reaches a critical length associated with unstable, rapid crack extension, namely fracture.

Fracture toughness reflects the tolerance of the steel for a crack prior to fracture. Fracture of steel bridges is governed by the total stress, including the dead-load stress, and not just the live-load stress range as is the case with fatigue. Older bridges, such as the Bourne and Sagamore bridges which have a satisfactory performance history, likely have adequate fracture toughness for the maximum total stresses that they have experienced.

a. Section Properties

Section moduli were obtained from the Load Rating and Analysis Report, Bourne and Sagamore Highway Bridges, June 2009, conducted by Parsons Brinckerhoff, and updated with the most recent bridge inspection reports. This included the main truss members, floorbeams and stringers. Net section properties of these members were then used to determine the stress ranges for the members.

b. AASHTO Stress Categories

The following categories for load-induced fatigue were investigated. All categories were matched to the most appropriate detail categories in LRFD Table 6.6.1.2.3-1—Detail Categories for Load-Induced Fatigue in order to obtain the threshold $(\Delta F)_{TH}$ parameters.

Table A-4 - Fatigue Details*

MEMBER NAME	AASHTO STRESS CATEGORY	DESCRIPTION (INSTALLATION DATE)
STRINGER	A	Rolled member, typical stringer at midspan (1935).
FLOORBEAM	D	Bottom flange at floorbeam at net section of riveted connections (1935).
FLBM – Welded Stiffener Repairs	E’	Plate welded to vertical leg of floorbeam bottom flange angle (1964). Welded floorbeam web stiffener repair welded to floorbeam bottom flange.
FLBM - End Flbms. - remnant drain trough welds; Welded gas main bracket	E	Utility pipe support angle welded to floorbeam web (1964). Stub plate continuously welded to floorbeam web (1962). CRACKED ONES REPAIRED 2013; OTHERS REMAIN.
TRUSS	D	Truss member at net section of riveted connection (1935).

*Note, a complete list of Fatigue Details is contained in the latest inspection reports for each bridge.

c. Truss Members

The truss chords and diagonals are built-up riveted members comprised of angles, channels, and plates fabricated into box members using lacing bars. The basic riveted members are assigned a fatigue resistance of category D, which is also more conservative. No cracking exists in any of the truss members.

The Constant Amplitude Fatigue Limit (CAFL) for category D is 7.0 ksi. The CAFL is the stress range that below which no fatigue crack growth would be expected. In other words, if all live load stress-range cycles were kept below the CAFL, no fatigue cracking should occur and the member or detail would be expected to have an infinite life. The riveted truss members all have a stress range below the CAFL and, therefore, have an infinite calculated fatigue life.

d. Stringers

The stringers are all rolled members. According to LRFD Table 6.6.1.2.3-1, the stringers have a fatigue category of A and a CAFL of 24 ksi. No cracking exists in any of the stringers. The stringers all have a stress range below the CAFL and, therefore, have an infinite calculated fatigue life. However, there are five fatigue sensitive details (welded attachments) located on some stringers that have a calculated finite fatigue life ranging from 3 years to 28 years. These details show no signs of cracks and are monitored every 24 months. In addition, these details are scheduled to be removed in the next steel repair contract or if a major rehab is undertaken.

e. Floorbeams

The floorbeams are built-up riveted members made up of a web plate and flange angles. A cover plate is located at mid-span of the floorbeam. The floorbeams are category D details (rivets) and have category E details (welded attachments).

The welds on these members were added as part of the previous installation of drainage components and as well as other miscellaneous attachments. It is noted that some of the welds placed on the web plate directly connect the angles to the web plate. These welds only appear to be located at end floorbeams (PP 0, 0', 10 and 10') where the original drainage system was installed. These welds provide a direct path for cracks to travel from one component to another, should they occur.

There are several details on the floorbeams that are of concern in terms of the fatigue limit state. The riveted members, in and of themselves, are category D details. However, due to the addition of various welded attachments, details with lower fatigue resistance have been placed on the floorbeams. Although these welded details have lower fatigue resistance, they are not all located in regions of high stress range (*e.g., the angle welded to the floorbeam web supporting the gas line is nearly at the neutral axis*).

The welds used to attach the gas-line support bracket to the floorbeam web are somewhat more straightforward in terms of their assessment. The longitudinal length of the weld used to attach the bracket (fabricated from a rolled angle) to the web determines if the joint is classified as a category C, D, or E detail. If there is a weld placed on the horizontal leg of the support angle, the detail will be considered category E, since the length of the weld will be greater than four inches.

With the exception of the end floorbeams, all floorbeams are internally redundant since they are built-up riveted members. Hence, a crack in one flange component does not have a direct path into the others.

According to LRFD Table 6.6.1.2.3-1, the floorbeams have a fatigue category of D and a CAFL of 7 ksi. No cracking exists in any of the floorbeams. The floorbeams all have a stress range below the CAFL and, therefore, have an infinite calculated fatigue life.

The floorbeams with various fatigue sensitive details that are categorized as E (CAFL of 4.5 ksi) and E' (CAFL of 2.6 ksi) have a finite fatigue life. Current estimates of remaining fatigue life (based on previous fatigue life calculations) range from about 140 years to over 500 years for these details. However, some of these fatigue sensitive details are not located in areas of high stress (at or near the neutral axis of the member) and these details have shown no signs of cracks due to fatigue.

All of the fatigue sensitive details are routinely monitored for cracks. In addition, these details are scheduled to be removed in the next steel repair contract or if a major rehab is undertaken.

f. Traffic

The latest Annual Average Daily Traffic (AADT) was obtained from MassDOT's permanent traffic counting stations nearest the bridges. The most recent 10-year average was chosen for the analysis at both bridges. The AADT for the Bourne Bridge was 44,447 and the Sagamore Bridge was 51,756.

Based on LRFD Table C3.6.1.4.2-1, the fraction of trucks in traffic for a highway classified as 'Urban Interstate' is 0.15. Using these data, the present average number of trucks per day for all directions of truck traffic $[\mathrm{ADTT}]_{\mathrm{PRESENT}}$ was computed. The $[\mathrm{ADTT}]_{\mathrm{PRESENT}}$ was used to estimate the total fatigue life of the previously described truss and floor system members and details.

g. Live Load

The load applied for fatigue analysis comprises the HL-93 design truck with a fixed rear axle spacing of 30 feet between the 32-kip axles. The 30-foot rear axle spacing represents an average axle spacing as opposed to the variable spacing used for design purposes. Fatigue is not based upon a single one-off load, but on the vast majority of average trucks crossing the bridge.

i) Distribution factor

LRFD 3.6.1.4.3 states that the distribution factor (DF) to be used to approximate the load distribution shall be the DF for one-traffic lane. Distribution factors were obtained from the load rating conducted by Parsons Brinckerhoff. The lever rule was used to obtain the controlling DF of 0.84.

ii) Dynamic load allowance

A dynamic load allowance of 15% is applied to the truck, representing average conditions. LRFD 3.6.2 specifies a dynamic load allowance for the Fatigue Limit State of 15%.

iii) Live Load Moment

In order to determine the maximum live load moment at the member of interest, the fatigue truck was applied to the truss models previously developed by Parsons Brinckerhoff for the load rating.

h. Infinite Life Check

The infinite-life check of all fatigue prone details was performed in accordance with MBE 7.2.4. In theory, a fatigue-prone detail will experience infinite life if the stress range at that particular detail is below a constant amplitude fatigue threshold, $(\Delta F)_{TH}$. If the stress range of the member or detail exceeds the threshold, the total fatigue life should be estimated.

i. Estimating Finite Fatigue Life

Certain fatigue sensitive details on both the stringers and the floorbeams indicated a finite fatigue life, but these specific fatigue sensitive details are monitored every 24 months during each routine inspection. In addition, these specific FSD's would be remediated either during a major rehabilitation project or the next scheduled steel repair contract prior to any specific rehabilitation project.

Also, although no site-specific stress measurements have been obtained for either the Bourne or Sagamore bridges, calculated fatigue stress ranges can overestimate the actual in-service stress ranges. Often, this is due to unaccounted stress redistribution among structural components, simplifications in structural analysis models, and inaccurate load models.

j. Fatigue Summary

The primary load carrying members comprised of the riveted truss members, rolled stringers, and built-up floorbeams all have an infinite calculated fatigue life. FSD's that are categorized as E and E' on the floorbeams having a finite fatigue life and FSD's located on certain stringers with category D or E welds. Some of these fatigue sensitive details are not located in areas of high stress and these details have shown no signs of cracks due to fatigue. Regardless, all of the fatigue sensitive details on the trusses, floorbeams or stringers are routinely monitored for cracks.

6. CORROSION ANALYSIS SUMMARY

A corrosion analysis was conducted to aid in determining the overall long-term impact of corrosion on various bridge members, including the trusses, floorbeams, stringers and gusset plates, in relation to load rating factors over the 50-year study period.

For example, the rating factor of a truss member which is currently above 1.0, could possibly become less than 1.0 after accounting for corrosion over a 50-year study period. This is a factor which could lead to the possibility of needing to post the bridge at some point within that 50-year time period. Rating factors below 1.0 are only an indicator of posting (i.e. legally reducing the weight of vehicles permitted to cross the bridge), since a detailed load rating analysis for all members of these bridges was not conducted for this study.

a. Rate of Corrosion

An analysis of the rate of corrosion was accomplished for this study. Corrosion rates for this study were determined from measurements taken on fascia stringers of the Sagamore Bridge and on truss members and gusset plates of both the Sagamore and Bourne Bridges. All of these members are original steel members comprised of silicon steel. Silicon steel was used in various members of the trusses of these bridges due to its relatively high strength. The addition of silicon to steel contributes to the strength and hardness of the material.

The ISO Standard 9223 (Reference p) is widely used outside the U.S. for classification of environmental corrosivity. This reference defines various service environment categories. This standard breaks down into corrosivity categories from C1 (mild) to C5 (severe) with an additional category, C5M (severe marine) for marine exposures. The expected range of corrosion rate for each classification is shown in Table A-5. While this standard is not widely used in the highway bridge industry in the U.S., it has gained popularity for offshore and utility structures and an increasing number of coatings suppliers and researchers are referring to this classification system for generating performance data and recommending materials.

From Figure A-6-1, the average rate of corrosion for the Sagamore and Bourne Bridges is 0.0027 inches/yr. This rate of corrosion is consistent with Category C4, shown in Table A-6-1 below. The C4 category represents coastal areas with moderate salinity. This rate of corrosion is based on actual measurements of original steel components. These components have received regular maintenance of their coatings during their service life, therefore, it is assumed that this rate of corrosion includes continued maintenance painting of the bridges.

Table A-5 - Carbon Steel Corrosion Rates for Various Environments According to ISO 9223

Service Environment	Carbon Steel Corrosion Rate (in. per year)
C1 - Very Low	0.00005
C2 - Low	<0.001
C3 - Medium	0.001 to 0.002
C4 - High	0.002 to 0.003
C5I - Very High (Industrial)	0.003 to 0.008
C5M - Very High (Marine)	0.008 to 0.028

Table A-6-1 – Corrosion Rates

BRIDGE OR LOCATION	AVG. CORROSION RATE (IN./YR.)	SOURCE
SAGAMORE - STRINGERS	0.0017 - 0.0018	On site - 2013
SAGAMORE – TRUSS MEMBERS	0.0039	REFERENCES g & h
BOURNE – TRUSS MEMBERS	0.0023	REFERENCES i & j
SAGAMORE – GUSSET PLATES	.0027	REFERENCES g & h
BOURNE – GUSSET PLATES	.0027	REFERENCES i & j
AVERAGE	**0.0027**	
MARINE ENVIR., CAPE KENNEDY, FL (0.5 MI, FROM COAST)	0.00162	REFERENCE n, TABLE 1
MARINE ENVIR., CAPE KENNEDY, FL (60 YD. FROM COAST, 60 FT. ELEV.)	0.00241	REFERENCE n, TABLE 1
MARINE ENVIR., CAPE KENNEDY, FL (60 YD. FROM COAST, 30 FT. ELEV.)	0.00279	REFERENCE n, TABLE 1
MARINE ENVIR., KURE BEACH, NC (800 FT. FROM COAST)	0.00335	REFERENCE n, TABLE 1
C3 – COASTAL AREAS WITH LOW SALINITY	0.001 – 0.002	REFERENCES n & p
C4 – COASTAL AREAS WITH MODERATE SALINITY	0.002 – 0.003	REFERENCES n & p

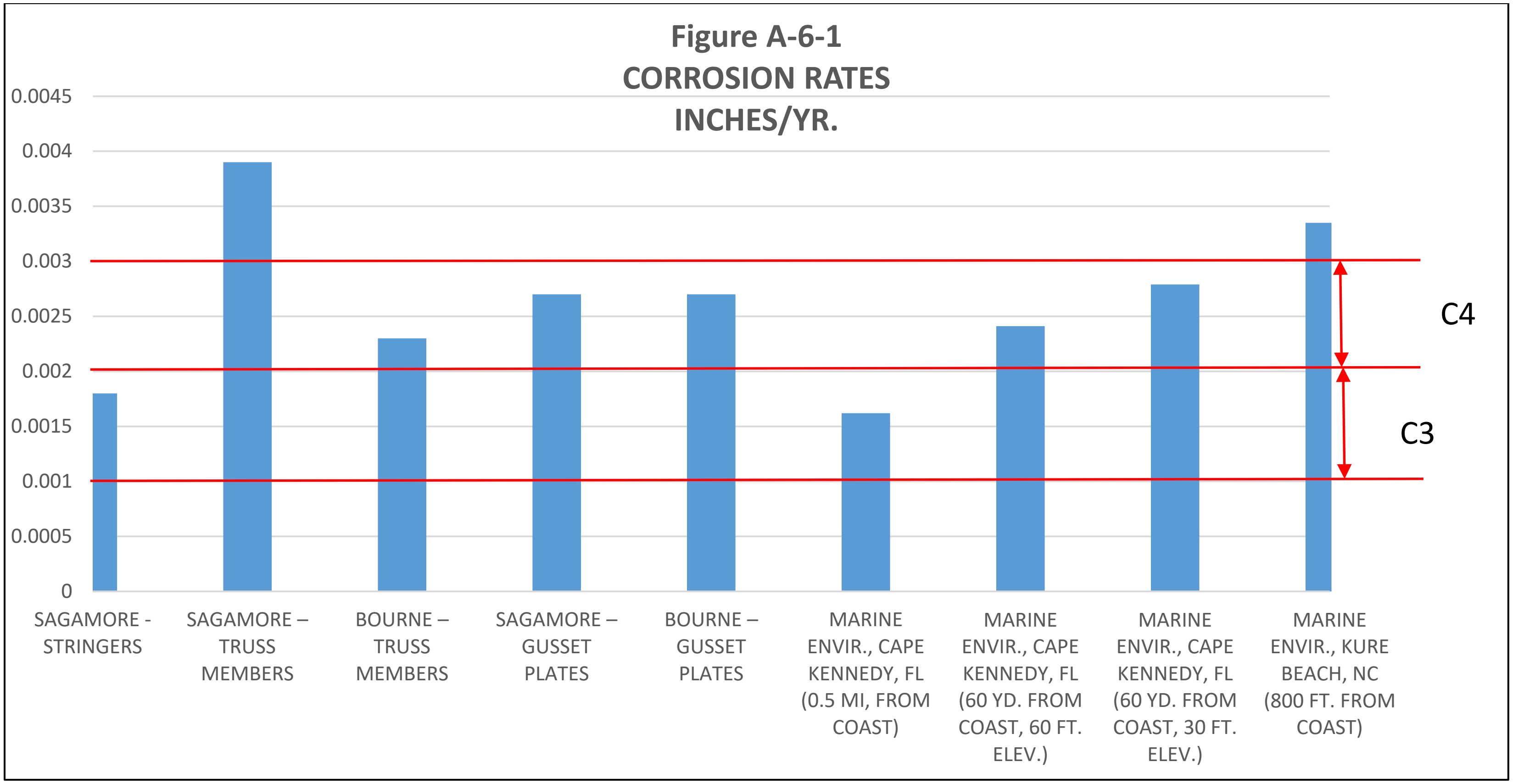


Figure A-6-1
CORROSION RATES
INCHES/YR.

b. Corrosion Results

The rate of corrosion was applied to critical members such as floorbeams, stringers and gusset plates. The results are summarized below.

i) Floorbeams

The controlling floorbeam rating (HS-20) for each bridge is within Spans 1, 2 and 3. This was revised for each 10-year period of the study (see Table 6-2 below). The current HS-20 controlling floorbeam rating is 0.87 and occurs on both bridges for Spans 1, 2 and 3. By the end of the 50-year study period, assuming a linear rate of corrosion of 0.0027 inches per year applied to the bottom flange angles and plates, this rating is reduced to about 0.74. While a bridge is not posted for HS-20 trucks, it is an indication that as the HS-20 rating lowers due to corrosion, it is also likely that the Massachusetts State legal (posting) loads will also be lowered, leading to eventual posting of the bridge. This is an indication that without either a major rehab or repair contract, the floorbeams will result in the need to place weight restrictions on each bridge for the Massachusetts legal loads in approximately 2036.

Since the floorbeams are currently rated at 0.87 (and no posting is required), it's strictly engineering judgement that by the time the rating factor is around 0.81 or 0.82 in 20 years, a weight restriction (load posting) may be necessary. This would mean potential load limits would be placed on either or both bridges in about 20 years from the date of analysis, or around 2036.

Certainly by the end of the 50-year period, overweight permit loads will routinely be denied from crossing either bridge due to the condition of the floorbeams. Table A-6-3 summarizes the linear assessment of corrosion on the floorbeams over the next 50 years. An elevation of a typical floorbeam with various cross-sections indicated is shown below.

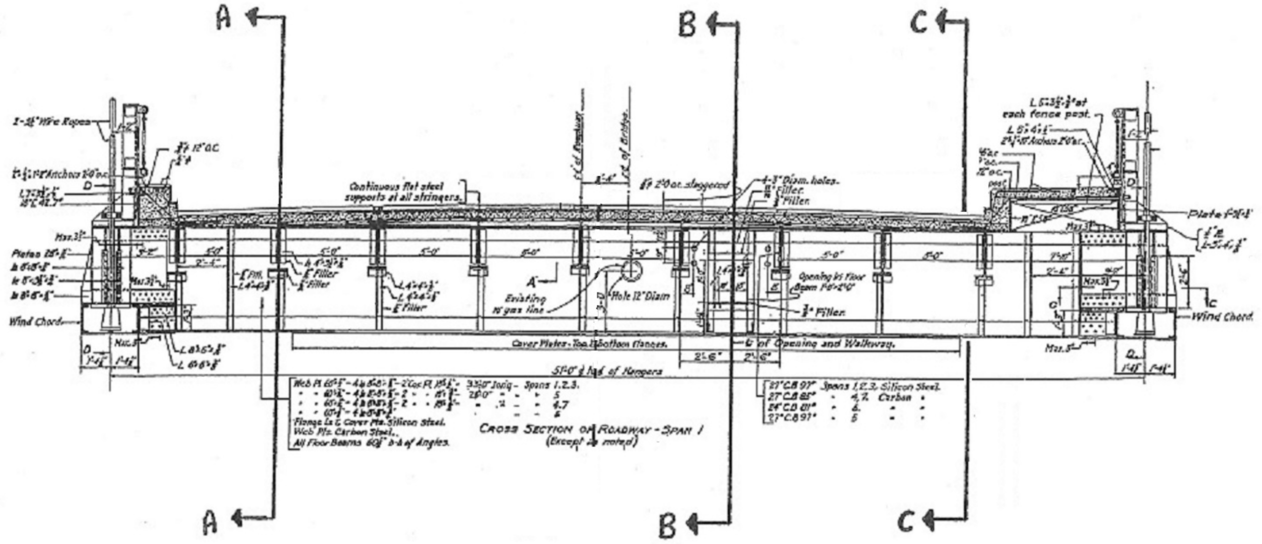

A
B
C
Wind Chord
Continuous flat steel supports at all stringers.
Existing 16" gas line
Hole 12" Diam.
Cover Plates - Top & Bottom flanges.
51'-0" c. to c. of Hangers
Web Pl. 60"×⅜" - 4 Ls 6"×6"×⅝" - 2 Cov. Pl. 18"×⅝" - 33'-0" long - Spans 1, 2, 3.
Flange Ls & Cover Pls. Silicon Steel.
Web Pls. Carbon Steel.
All Floor Beams 60" b. to b. of Angles.
CROSS SECTION OF ROADWAY - SPAN 1
(Except as noted)
℄ of Opening and Walkway.
Opening in Floor Beam
27" C.B. 97" Spans 1, 2, 3. Silicon Steel.
Plate
Wind Chord

Table A-6-2 – Floorbeam HS-20 Inventory Rating Factors

BRIDGE/SPAN		@ PRESENT	@ T=10 YRS.	@ T=20 YRS.	@ T=30 YRS.	@ T=40 YRS.	@ T=50 YRS.
		0	**10**	**20**	**30**	**40**	**50**
SAGAMORE BRIDGE							
SPANS 1, 2 & 3							
	SECT. MOD. (IN^3) @ A-A	1202.51	1183.54	1164.51	1145.50	1126.42	1107.37
	SECT. MOD. (IN^3) @ B-B	1746.74	1722.46	1698.14	1673.80	1649.43	1625.04
	SECT. MOD. (IN^3) @ C-C	1202.51	1183.54	1164.51	1145.50	1126.42	1107.37
	HS-20 INV RATING FACTOR	0.87	0.84	0.81	0.78	0.76	0.73
BOURNE BRIDGE							
SPANS 1, 2 & 3							
	SECT. MOD. (IN^3) @ A-A	1235.44	1216.13	1196.77	1177.42	1158.02	1138.64
	SECT. MOD. (IN^3) @ B-B	1752.65	1728.48	1704.28	1680.05	1655.79	1631.51
	SECT. MOD. (IN^3) @ C-C	1235.44	1216.13	1196.77	1177.42	1158.02	1138.64
	HS-20 INV RATING FACTOR	0.87	0.85	0.82	0.79	0.76	0.74

ii) Stringers

The controlling stringer rating (HS-20) for each bridge was revised for each 10-year period of the study. The current HS-20 controlling stringer rating is 0.96 and occurs at interior stringers on the Bourne Bridge for Spans 1, 2 and 3. Using the previously calculated rate of corrosion of 0.0027" per year and applying this to the stringer rating factors computed by Parsons Brinckerhoff, the stringers in Spans 1, 2 and 3 control the rating factor for stringers.

The interior stringers on both bridges in Spans 1, 2 and 3 will require rehabilitation or replacement in Year 10 for the Bourne Bridge and Year 20 for the Sagamore Bridge. Exterior stringers will require rehabilitation or replacement in Year 30 for both bridges.

This is an indication that without either a major rehabilitation or repair contract, the stringers will result in the need to place weight restrictions on each bridge for the Massachusetts legal loads in approximately 2026 for the Bourne Bridge and 2036 for the Sagamore Bridge. Certainly by the end of the 50-year period, overweight permit loads will routinely be denied from crossing either bridge due to the condition of the stringers.

Table 6-3 summarizes the linear assessment of corrosion on the stringers over the next 50 years.

Table A-6-3 – Stringer HS-20 Inventory Rating Factors

BRIDGE/SPAN		@ PRESENT	@ T=10 YRS.	@ T=20 YRS.	@ T=30 YRS.	@ T=40 YRS.	@ T=50 YRS.
		0	**10**	**20**	**30**	**40**	**50**
SAGAMORE BRIDGE - SPANS 1, 2 & 3							
INTERIOR STRINGER	**SECTION MODULUS (IN^3)**	219.97	215.57	211.26	207.03	202.89	198.84
	HS-20 INV RATING FACTOR	0.99	0.96	0.93	0.90	0.87	0.84
EXTERIOR STRINGER	**SECTION MODULUS (IN^3)**	219.97	215.57	211.26	207.03	202.89	198.84
	HS-20 INV RATING FACTOR	1.06	1.02	0.98	0.95	0.91	0.88
BOURNE BRIDGE – SPANS 1,2 & 3							
INTERIOR STRINGER	**SECTION MODULUS (IN^3)**	215.39	211.08	206.86	202.72	198.67	194.70
	HS-20 INV RATING FACTOR	0.96	0.93	0.90	0.87	0.84	0.82
EXTERIOR STRINGER	**SECTION MODULUS (IN^3)**	216.60	212.27	208.02	203.86	199.78	195.79
	HS-20 INV RATING FACTOR	1.03	0.99	0.96	0.92	0.89	0.85

iii) Gusset Plates

Gusset plates are all non-redundant and are considered fracture critical members (FCM), meaning the failure of one of these elements will likely lead to catastrophic failure of an entire span. Therefore, the importance of gusset plates to the overall structural integrity of the bridges cannot be overstated.

A comprehensive load rating of all the gusset plates was beyond the scope of this investigation. However, using the previous gusset plate load rating performed by Parsons Brinckerhoff in 2011, recent bridge inspection reports, and the linear rate of corrosion of 0.0027 inches per year, a list of priority gusset plates was developed, as shown below in Tables 6-4 and 6-5. These are HS-20 load rating factors, which is a reflection of a reduction in overall load capacity associated with deterioration of these members. It is also an indication of the possible need for future weight restrictions on the bridges.

It is important to note that although one specific location is listed, the assumption is that all similar locations for both the Bourne and the Sagamore bridges will require rehabilitation. This is due to truss symmetry in configuration, similar materials and age, and identical environments causing deterioration and corrosion within both bridges.

Therefore, if a particular location has a low rating factor, it would apply to similar locations on both trusses at both bridges requiring rehabilitation or repair.

At the current rate of corrosion, various main truss gusset plates will likely have rating factors less than 1.0 in ten to twenty years.

Those gusset plates where the fastener shear controlled the rating are not included in this table because fastener shear is more easily rectified by simply replacing the existing rivets with high-strength bolts and is not influenced by the current rate of corrosion. These locations would be repaired during any major rehabilitation or steel repair project.

Tables 6-4 and 6-5 summarize the linear assessment of corrosion on the gusset plates over the next 50 years.

Table A-6-4 – Bourne Bridge Gusset Plate HS-20 Inventory Rating Factors

BRIDGE/SPAN/PANEL POINT	RESISTANCE TYPE	@ PRESENT	@ T=10 YRS.	@ T=20 YRS.	@ T=30 YRS.	@ T=40 YRS.	@ T=50 YRS.
INTERIOR GUSSET PLATES							
BOURNE BRIDGE - SPAN 4							
L2	PLATE THICKNESS (INCHES)	0.5000	0.4730	0.4460	0.4190	0.3920	0.3650
	GROSS SECTION YIELDING (TENSION)	1.26	1.11	0.95	0.80	0.65	0.50
L3	PLATE THICKNESS (INCHES)	0.3750	0.3480	0.3210	0.2940	0.2670	0.2400
	COMPRESSION BUCKLING	1.71	1.41	1.37	1.20	1.03	0.86
BOURNE BRIDGE - SPAN 3							
U2	PLATE THICKNESS (INCHES)	0.7500	0.7230	0.6960	0.6690	0.6420	0.6150
	COMPRESSION BUCKLING	1.08	0.97	0.86	0.76	0.65	0.54
L1	PLATE THICKNESS (INCHES)	0.3750	0.3480	0.3210	0.2940	0.2670	0.2400
	GROSS SECTION YIELDING (TENSION)	1.44	1.28		0.96	0.80	
L3	PLATE THICKNESS (INCHES)	0.3750	0.3480	0.3210	0.2940	0.2670	0.2400
	GROSS SECTION YIELDING (TENSION)	1.41	1.25	1.09			0.61
BOURNE BRIDGE - SPAN 5							
U7	PLATE THICKNESS (INCHES)	0.6250	0.5980	0.5710	0.5440	0.5170	0.4900
	GROSS SECTION YIELDING (SHEAR)	1.00	0.89				0.45
EXTERIOR GUSSET PLATES							
BOURNE BRIDGE - SPAN 4							
L2	PLATE THICKNESS (INCHES)	0.5000	0.4730	0.4460	0.4190	0.3920	0.3650
	GROSS SECTION YIELDING (TENSION)	1.26	1.11	0.95	0.80	0.65	0.50
L3	PLATE THICKNESS (INCHES)	0.3750	0.3480	0.3210	0.2940	0.2670	0.2400
	COMPRESSION BUCKLING	1.71	1.41	1.37	1.20	1.03	0.86
BOURNE BRIDGE - SPAN 3							
U2	PLATE THICKNESS (INCHES)	0.3750	0.3480	0.3210	0.2940	0.2670	0.2400
	COMPRESSION BUCKLING	2.2900	1.400	0.910	0.510	0.200	0.000

Table A-6-5 – Sagamore Bridge Interior Gusset Plate HS-20 Inventory Rating Factors

BRIDGE/PANEL POINT	RESISTANCE TYPE	@ PRESENT	@ T=10 YRS.	@ T=20 YRS.	@ T=30 YRS.	@ T=40 YRS.	@ T=50 YRS.
SAGAMORE BRIDGE							
U0	PLATE THICKNESS (INCHES)	0.4688	0.4418	0.4148	0.3878	0.3608	0.3338
	COMPRESSION BUCKLING	1.50	1.38	1.26	1.14	1.02	0.89
U4	PLATE THICKNESS (INCHES)	0.5625	0.5355	0.5085	0.4815	0.4545	0.4275
	COMPRESSION BUCKLING	1.11	1.00	0.89	0.78	0.67	0.56
U6'	PLATE THICKNESS (INCHES)	0.5000	0.4730	0.4460	0.4190	0.3920	0.3650
	GROSS SECTION YIELDING (TENSION)	2.0300	1.870	1.710	1.550	1.390	1.230
L1	PLATE THICKNESS (INCHES)	0.2500	0.2230	0.1960	0.1690	0.1420	0.1150
	GROSS SECTION YIELDING (TENSION)	1.44	1.28	1.11	0.96	0.80	0.63
L3	PLATE THICKNESS (INCHES)	0.2500	0.2230	0.1960	0.1690	0.1420	0.1150
	GROSS SECTION YIELDING (TENSION)	1.41	1.25	1.08	0.93	0.77	0.61
L7	PLATE THICKNESS (INCHES)	0.5000	0.4730	0.4460	0.4190	0.3920	0.3650
	GROSS SECTION YIELDING (TENSION)	2.05	1.81	1.57	1.33	1.09	0.85
U11	PLATE THICKNESS (INCHES)	0.7080	0.6810	0.6540	0.6270	0.6000	0.5730
	GROSS SECTION YIELDING (SHEAR)	1.13	1.05	0.98	0.90	0.82	0.74
U13	PLATE THICKNESS (INCHES)	0.7500	0.7230	0.6960	0.6690	0.6420	0.6150
	COMPRESSION BUCKLING	1.1600	1.060	0.960	0.860	0.750	0.640
U8	PLATE THICKNESS (INCHES)	0.8750	0.8480	0.8210	0.7940	0.7670	0.7400
	GROSS SECTION YIELDING (SHEAR)	1.40	1.30	1.21	1.11	1.01	0.91
U2	PLATE THICKNESS (INCHES)	0.7500	0.7230	0.6960	0.6690	0.6420	0.6150
	COMPRESSION BUCKLING	1.93	1.82	1.72	1.61	1.51	1.40

Table A-6-5 (CONT.) – Sagamore Bridge Exterior Gusset Plate HS-20 Inventory Rating Factors

BRIDGE/PANEL POINT	RESISTANCE TYPE	@ PRESENT	@ T=10 YRS.	@ T=20 YRS.	@ T=30 YRS.	@ T=40 YRS.	@ T=50 YRS.
SAGAMORE BRIDGE							
U0	PLATE THICKNESS (INCHES)	0.3750	0.3480	0.3210	0.2940	0.2670	0.2400
	COMPRESSION BUCKLING	2.17	1.94	1.70	1.45	1.19	0.91
U4	PLATE THICKNESS (INCHES)	0.3750	0.3480	0.3210	0.2940	0.2670	0.2400
	COMPRESSION BUCKLING	3.00	2.71	2.41	2.10	1.76	1.39
U6'	PLATE THICKNESS (INCHES)	0.7500	0.7230	0.6960	0.6690	0.6420	0.6150
	GROSS SECTION YIELDING (TENSION)	3.49	3.33	3.17	3.02	2.86	2.70
L1	PLATE THICKNESS (INCHES)	0.3130	0.2860	0.2590	0.2320	0.2050	0.1780
	GROSS SECTION YIELDING (TENSION)	1.81	1.65	1.49	1.33	1.17	1.01
L3	PLATE THICKNESS (INCHES)	0.2500	0.2230	0.1960	0.1690	0.1420	0.1150
	GROSS SECTION YIELDING (TENSION)	1.41	1.25	1.08	0.93	0.77	0.61
L7	PLATE THICKNESS (INCHES)	0.3125	0.2855	0.2585	0.2315	0.2045	0.1775
	GROSS SECTION YIELDING (TENSION)	2.05	1.81	1.57	1.33	1.09	0.85
U11	PLATE THICKNESS (INCHES)	0.7080	0.6810	0.6540	0.6270	0.6000	0.5730
	GROSS SECTION YIELDING (SHEAR)	1.13	1.05	0.98	0.90	0.82	0.74
U13	PLATE THICKNESS (INCHES)	0.7500	0.7230	0.6960	0.6690	0.6420	0.6150
	COMPRESSION BUCKLING	1.16	1.06	0.96	0.86	0.75	0.64
U8	PLATE THICKNESS (INCHES)	0.8750	0.8480	0.8210	0.7940	0.7670	0.7400
	GROSS SECTION YIELDING (SHEAR)	1.40	1.30	1.21	1.11	1.01	0.91
U2	PLATE THICKNESS (INCHES)	0.3750	0.3480	0.3210	0.2940	0.2670	0.2400
	COMPRESSION BUCKLING	3.9600	3.620	3.250	2.850	2.410	1.890

c. Corrosion Summary

This simplified linear corrosion analysis found that various main truss gusset plates will likely have rating factors less than 1.0 in ten to twenty years. This means that significant costs will need to be incurred to replace or rehabilitate these gusset plates within the 50-year study period in order to prevent the bridges from being posted for weight restrictions.

Both the stringers and the floorbeams will have reduced capacity and may result in the need to initiate weight restrictions on both bridges in 20 to 30 years, or less. It is also likely that overweight permits will also need to be restricted when the bridge is load posted.

7. ALTERNATIVES

There are three alternatives which have been investigated.

1) Base Condition
2) Major Rehabilitation
3) Bridge Replacement

a. Base Condition

This alternative is synonymous with a "without project" condition, and assumes that the bridges will continue to be operated efficiently and with due diligence for vehicular and marine safety. In the event of unsatisfactory performance of a bridge component, it is assumed that emergency funding will be made available to address the deficiency. This scenario portrays a condition where the reliability of the bridges is allowed to fall below the current condition, but that the bridge remains functional. For the Base Condition alternative, the following items would continue to be maintained or repaired on the three main areas of the bridges:

Superstructure
1. Advanced deterioration of secondary member, non-critical gusset plate, stringer, floorbeam, or hanger cable.
2. Advanced deterioration of main truss member or critical gusset plate.
3. Catastrophic damage to main truss member or critical gusset plate.

Deck
1. Localized deterioration of roadway joint(s), granite curbs, concrete-filled steel grid over bridge spans, or reinforced concrete deck at the abutments.
2. Widespread deterioration of concrete-filled steel grid deck over bridge spans and reinforced concrete deck at abutments.

Substructure
1. Localized concrete defects such as cracks or spalls on vertical surfaces of piers or degradation of concrete under bearings on piers.
2. Widespread concrete defects such as cracks or spalls on vertical surfaces of piers or degradation of concrete under bearings on piers.

b. Major Rehabilitation

Major rehabilitation items are large scale projects including structural improvements that are performed less frequently, outside of the purview of normal maintenance, and are aimed at prolonging the service life of the bridge, maintaining an acceptable load carrying capacity, and preserving overall public safety on the structure. Contractors are generally hired for these major work items since the work required is somewhat specialized in most cases. It is estimated that a full rehabilitation project would take 4 years for each bridge. Assuming a project start in 2021, the rehabilitation of both bridges would extend to 2029, as working on both bridges concurrently would present an unacceptable impact to the region.

This scenario assumes that all known structural deficiencies on both bridges will be addressed under a major rehabilitation contract. This would include multiple large projects undertaken in successive construction seasons in order to provide a comprehensive rehabilitation of both the Bourne and Sagamore Bridges.

Minimizing traffic congestion and impacts during a Major Rehabilitation requires keeping at least one of the bridges open with no traffic control at any given time. Therefore, in order to provide sufficient traffic capacity and lessen adverse impacts to traffic throughout the duration of a major rehabilitation project, only one bridge at a time can be worked on, thus extending the overall timeframe for completing a major rehabilitation project for both bridges. This would alleviate traffic concerns by limiting lane closures to occurring one bridge at a time.

Some aspects of a major rehabilitation will likely require complete bridge closure. For example, this would likely include projects such as replacement of interior gusset plates. While there may be certain projects which could be done concurrently on both bridges, development of a comprehensive construction schedule is outside the scope of this study.

The anticipated scope of a future major rehabilitation undertaking would include the following items:

b.1 Truss Span Deck Replacement
b.2 Stringer Replacement/Repair
b.3 Floorbeam Repair
b.4 Suspender Cable Replacement
b.5 Replace Abutment Spans
b.6 Bearing Repairs
b.7 Joint Replacement
b.8 Minor Steel Truss Repairs
b.9 Major Steel Truss Repairs
b.10 Paving (Overlay)
b.11 Painting of Structural Steel

b.1 Truss Span Deck Replacement:

The lightweight concrete filled steel grid deck was replaced in 1979 on the Bourne Bridge and 1981 on the Sagamore Bridge. A typical service life for this type of deck is 40+ years. Although the current structural condition of the deck is good, it means that the deck will likely need replacing c. 2025. Replacement of the deck would require significant lane closures and would run concurrent with major steel repairs below the deck.

b.2 Stringer Replacement/Repair:

The current stringers are in overall fair condition for both bridges, except for the fascia stringers, some of which exhibit significant pitting and section loss to the bottom flanges. Numerous original stringers were replaced during the deck replacement projects for both bridges in 1979 and 1981. Although there are currently no structural load capacity issues with these stringers, in the event of a deck replacement project, these fascia stringers would be replaced to ensure structural load capacity is maintained. Therefore, fascia stringer replacement would take place in conjunction with a deck replacement project c.2025. Repairs to stringers would involve the addition of cover plates (to improve load carrying capacity) and the removal of any fatigue sensitive details.

b.3 Floorbeam Repair:

The floorbeams are in fair condition on both bridges. However, the floorbeams under the joints are particularly vulnerable to corrosion due to leaking of failed bridge joints. No floorbeams have been replaced on either bridge, but the recent steel repair project in 2012 included repairs to some floorbeams. It is likely that the number of required floorbeam repairs will increase as the bridge ages. Repairs would likely include the addition or replacement of cover plates and the removal of any fatigue sensitive details.

b.4 Suspender (Hanger) Cable Replacement:

The suspender, or hanger, cables were replaced in 1981 on the Sagamore Bridge and in 1986 on the Bourne Bridge. There are 13 pairs of cables per side of each bridge. Temporary jacking beams are required to remove cable pairs. This work can be done with the deck replacement project. Cables such as this typically have a service life about 50 years, but the service life varies based on the environment and loading experienced by the cables. Over time, degradation and elongation of the bridge cables will determine the need for replacement.

b.5 Replace Abutment Spans (Transverse Girders; T-Beams & Deck)

The concrete T-beams at the Bourne Bridge are in poor condition. The T-beams at the Sagamore Bridge are in fair condition. The T-beams were repaired c. 2000 at both bridges, but these repairs were localized. Further rehabilitation will require extensive concrete repairs to the beams to maintain their overall structural integrity. Complete replacement is required in order to significantly increase the service life of these elements. Though the present state of this damage does not adversely affect the structural adequacy, if neglected for extended periods of time structural adequacy would be affected.

Over one-third of the area of the concrete deck of the abutments at the Sagamore Bridge is in poor condition. The Bourne Bridge abutment concrete deck is on overall good condition. The concrete deck on the abutments has been repaired numerous times since original construction of the bridges. There are various repair materials making up the total depth of the concrete deck, much of which is deteriorated. This deteriorated condition results in premature failure of any pavement overlay. The decks require replacement to regain the overall integrity of the abutment spans.

Since the replacement of these elements will require the typical 3-phase traffic control approach, replacement of the abutment spans should be undertaken at the same time as a truss span deck replacement project.

b.6 Bearing Repairs:

The bearings are in overall poor condition at both bridges. There are 24 bearings at the Bourne and 8 at the Sagamore. Repairs would include any necessary seismic retrofits as well as installing new anchor bolts.

b.7 Joint Replacement:

The existing joints are in serious to good condition at both bridges. At the Sagamore Bridge, the modular joint system at the south abutment installed c. 1995 was in serious condition due to significant spalling of the concrete supports and deterioration of the support bars within the joint resulting in a vertical misalignment. This joint and supporting concrete was replaced in 2018. All of the compression seal joints were also replaced in 2018.

At the Bourne Bridge, the Pier 3 Waboflex deck joint exhibits significant deflection under live loads and general deterioration throughout. This joint was partially repaired in 2010. The Transflex modular joint at Pier 4 is also deteriorated, misaligned, and has broken splice keys. Minor temporary repairs were made c. 2005. The compression strip seals were all replaced in 2010 and on both bridges are now dislodged, missing, torn, or generally damaged and deteriorated. Both Pier 3, Pier 4, and all the compression joint seals were replaced in Spring of 2019.

b.8 Minor Steel Truss Repairs:

Minor steel repairs would include all aspects of the steel repair project completed in 2011-2013 on both bridges at a cost of $9.5 million. This included repairing or replacing some secondary bracings members, lacing bars, batten plates, etc., retrofitting main exterior truss gusset plates, and repairing various floorbeams and removing fatigue sensitive details on the trusses throughout the structure. Any further minor steel repairs would likely need to include further exterior gusset plate retrofits on the main truss members, as well as repairs to some of the main truss members, secondary bracing, floorbeams, and stringers.

b.9 Major Steel Truss Repairs:

Major steel repairs would include the replacement of various members, as needed. This would include complete replacement of floorbeams and interior gusset plates. This type of project requires extensive lane closures and most likely intermittent full bridge closure to all vehicular traffic during the course of this work.

Replacement of major supporting elements such as floorbeams would require complete closure during the replacement process. While this support system is in place, the bridge would likely have to be closed to all vehicular traffic. Removal of the deck at each floorbeam location to be replaced would likely be necessary.

Interior gusset plate replacement requires the temporary removal of numerous secondary bracing members and disconnecting the floorbeam and the main truss members from the gusset plate. These bridge members would require an extensive temporary support system. While this support system is in place, the bridge would likely have to be closed to all vehicular traffic.

b.10 Paving (Overlay):

While paving in itself is not a major rehabilitation item, it would be included as part of an overall Major Rehabilitation project. Paving was last accomplished in 2010 for both bridges. Paving would be done in conjunction with the deck replacement project.

A microsilica concrete overlay was put on the Sagamore Bridge abutment spans in 1987 and the Bourne abutment spans in 1988. This microsilica concrete was completely removed from the Sagamore Bridge abutment spans during the most recent paving in 2010 and was replaced with Rosphalt (Rosphalt is a proprietary product combining asphalt and a waterproofing substance into one layer). Only obviously deteriorated portions of the microsilica overlay were removed from the Bourne Bridge in 2010. The entire overlay was not removed.

b.11 Painting of Structural Steel:

While painting in itself is not a major rehabilitation item, it would be included as part of an overall Major Rehabilitation project. Painting of the bridges is the single best method for preserving the current condition of the structural steel. Active corrosion results in section loss and decreased load capacity of the members. Maintenance painting every 7 years would include spot cleaning and blasting to bare steel of significant coating deterioration/paint loss/corrosion and a brush-off blast of the entire structure prior to recoating the entire structure. Both bridges have undergone complete paint removal (deleading); the Bourne in 2006 and the Sagamore in 2014.

b.12 Traffic Management Issues During a Major Rehabilitation Project:

Traffic management will be a significant task during a Major Rehabilitation project. It will likely include multiple and lengthy lane closures throughout the duration of the project and significant time where complete bridge closure would be required. While this study did not analyze specific traffic control requirements or timeframes for the various major rehabilitation tasks, a generalized approach was used to provide an overall concept of what may be required for such a project.

The Major Rehab would likely require some form of lane closures and/or bridge closures. A Major Rehab project would include the following items that would likely require traffic control:

- Deck Replacement – This would include the replacement of fascia (exterior) stringers and various floorbeams and interior gusset plates which should be done concurrently with the removal of the deck. (Note, many steel replacement issues can and should be accomplished concurrently with the deck replacement).
- Exterior Gusset Plate Retrofit
- Interior Gusset Plate Repair or Replacement - This type of activity can be performed concurrently with the deck replacement.
- Suspender Cable Replacement
- Abutment Span Replacement (replacement of T-Beams and deck)
- Misc. Steel Repairs/Suicide Fence Repairs, etc.
- Misc. Concrete Repairs (abutment parapets, exterior of substructure, etc.)

- Paving
- Painting

The list above is not an all-encompassing list of items required during a Major Rehabilitation of either bridge, but rather an estimation of those activities which would likely require some form of traffic control utilizing NAE's typical 3-phase traffic control scheme, or which may require complete bridge closure. This is only meant to capture the larger critical issues. The engineering required to fully determine and document each specific major rehab item is outside the scope of this effort.

Table A-7-1 summarizes lane closure and full bridge closure timeframes for a Major Rehab of the Bourne and Sagamore Bridges. These are strictly gross estimates based on engineering judgement and similar previous work done at the bridges. The actual lane closure and bridge closure timeframes are best predicted as part of the development of engineering documents such as Plans and Specifications for each of these specific major rehabilitation activities.

Table A-7-1

MAJOR REHAB ACTIVITY	**BOURNE**	**SAGAMORE**
	LANE CLOSURE DURATION (DAYS)	
BRIDGE SUPERSTRUCTURE DECK REPLACEMENT (INCL. STRINGER REPLACEMENT); ABUTMENT SPAN REPLACEMENT; (CONCRETE T-BEAMS) MISC. STEEL REPAIRS, ETC.; EXTERIOR GUSSET PLATE RETROFITS; INTERIOR GUSSET PLATE REPAIRS; MISC. CONCRETE REPAIRS, ETC.	165	135
SUSPENDER CABLE REPLACEMENT	65	70
PAVING	30	25
PAINTING	220	150
TOTAL DAYS OF LANE CLOSURES	**480**	**380**
	FULL BRIDGE CLOSURE DURATION (DAYS)	
INTERIOR GUSSET PLATE REPLACEMENT	70	95
FLOORBEAM REPLACEMENT	110	35
TOTAL DAYS OF FULL BRIDGE CLOSURE	**180**	**130**

It was assumed that replacement of interior gusset plates and floorbeams would require complete bridge closure due to the nature of having to disconnect an entire truss panel point and temporarily support this with a saddle type beam located on the roadway deck above. Replacement of these interior gusset plates and floorbeams will require construction sequencing and methods that result in a full bridge closure to all vehicular traffic while these gusset plates and floorbeams are replaced.

It is anticipated that multiple bridge closure periods would be required over the course of a typical Major Rehabilitation project. Each closure would probably be sequenced and scheduled to have as minimal impacts as possible. Multiple interior gusset plate and/or floorbeam replacements could occur during any given period of full bridge closure, but time and physical constraints would still result in the likelihood of multiple bridge closures over the course of a Major Rehabilitation project.

Many of the rehabilitation items can be done concurrently with the total bridge superstructure deck replacement. For example, abutment span deck replacement, miscellaneous concrete repairs, miscellaneous steel repairs, and exterior and interior gusset plate repairs or retrofits could all be done concurrently with the bridge superstructure deck replacement.

The duration for lane and bridge closure would still be subjected to the time limits associated with NAE's normal O&M projects, which typically excludes placing traffic control on the bridge between Memorial Day through Columbus Day. Of course, weather delays, especially during the winter months, would extend the duration of any project. It is assumed that weather delays could account for 15-30 days during the winter months, based on past efforts.

The impacts on lengthy lane closures will be most significant for bridge superstructure deck replacement and replacement of the abutment spans (T-Beams and concrete deck). Time frames for items requiring full bridge closure will have enormous impacts on the local traffic pattern and likely the local economy, even if for just short lengths of time. Full bridge closures cannot be done piecemeal (i.e., 5 days during one month and 5 days the next month) but should be scheduled for specific lengths of time over the course of two or three construction seasons.

Critical path analysis of these types of rehab activities and required traffic control is outside the scope of this effort, but would be accomplished prior to, or during, the development of the Plans and Specifications for such a project.

b.13 Marine Traffic Management Issues During a Major Rehabilitation Project:

It was assumed that there would be minimal delays to marine navigation throughout the duration of a Major Rehabilitation project. Barge mounted cranes would likely not be necessary and were not used during the last major rehabilitation. Major Rehabilitation of both the Bourne and Sagamore Bridges was completed circa 1981. The work consisted of replacement of the bridge deck with a concrete-filled steel grid, replacement and repairs to deteriorated stringers, replacement of hanger cables, repair of secondary members, replacement of corroded rivets and lacing bars, and painting of the superstructure.

c. Bridge Replacement

This scenario postulates that two new vehicular bridges will be constructed, one parallel to the existing Bourne Bridge and the other parallel to the existing Sagamore Bridge. The existing Bourne and Sagamore Bridges would remain in service until the new bridges are constructed. For purposes of this study, a cable-stay bridge alternative was investigated. However, any bridge replacement would require further investigation to ascertain the most economical and favorable bridge type. This conceptual cable-stay bridge is based on the SR-1 bridge over the Chesapeake and Delaware Canal in Delaware.

This bridge type was chosen for this study, in part, because it is a USACE owned bridge over a marine navigation canal (the Chesapeake and Delaware Canal) of similar proportions to the Cape Cod Canal. It provides an alternative similar to what would be required for a new bridge to cross the Canal. A new bridge type and design have not been accomplished for this study. The bridge replacements described and shown below are only representative of what could be used as a replacement structure.

A new Bourne Bridge of this type would likely be approximately 19 to 23 spans with a total length of between about 3,500 to about 4,000 feet. The estimated length is based on the local topography, required elevation of the superstructure, accounting for sea level rise, and assuming a 4% roadway grade. It is also based on an arbitrary location of the abutments for each bridge.

This would be comprised precast segmental girders, cables for the cable-stay spans, and three spans of steel multi-girders. There would be two reinforced concrete abutments, 16 to 20 reinforced concrete piers, and two reinforced concrete pylons for the cable-stay span.

A new Sagamore Bridge of this type would likely be approximately 12 to 14 spans with a total length between about 2,400 to 3,000 feet. The length is based on the local topography, required elevation of the superstructure, accounting for sea level rise, and assuming a 4% roadway grade. It is also based on an arbitrary location of the abutments for each bridge.

This would be comprised of precast segmental girders, cables for the cable-stay spans, and three spans of steel multi-girders. There would be two reinforced concrete abutments, nine to 11 reinforced concrete piers, and two reinforced concrete pylons for the cable-stay span.

Conceptual bridge replacement profiles for both bridges are shown below. The final bridge alignment, height, grade, and overall configuration will likely be different from what is proposed for this study.

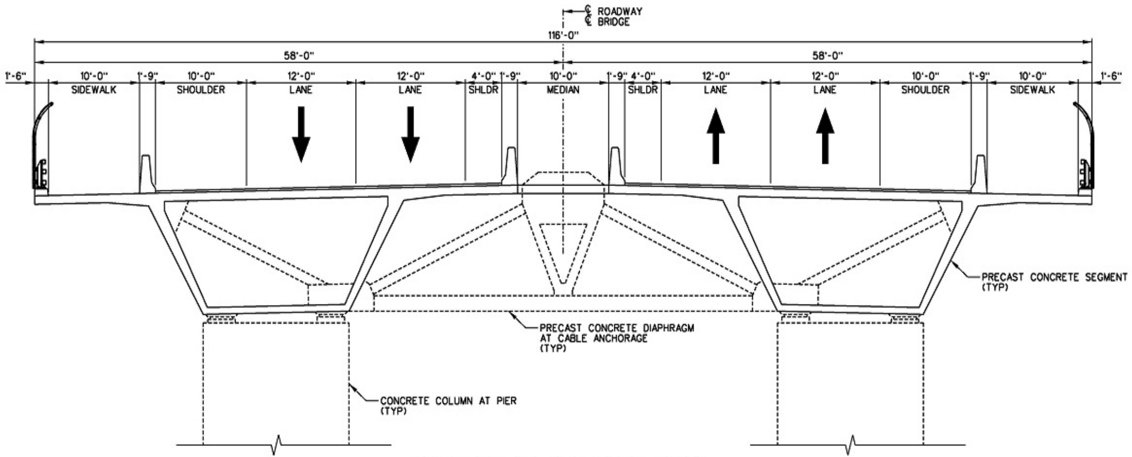
c.1 Traffic Management Issues During a Bridge Replacement Project:

Traffic management will be required during a Bridge Replacement project, but will not be as extensive and the time associated with lane closures will not be nearly as significant as for a Major Rehabilitation project. It will likely consist of various changes to traffic patterns necessitated by the reconfiguration of the approach roads to either bridge. It will not include any significant lane or bridge closures on the existing Bourne or Sagamore bridges themselves, whereas the new bridges would be constructed adjacent to the existing bridges.

This study did not analyze specific approach road traffic control requirements for the replacement of the Bourne and Sagamore bridges.

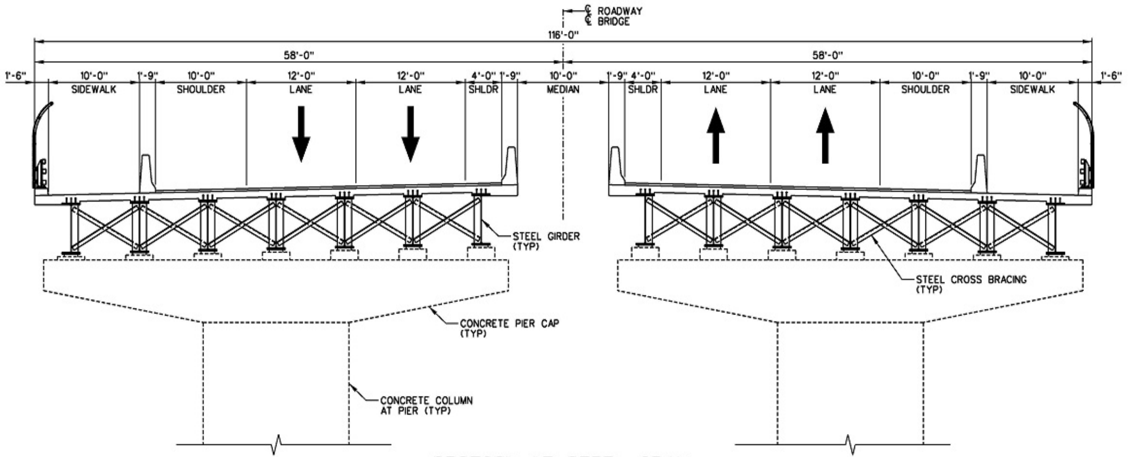
c.2 Marine Traffic Management Issues During a Bridge Replacement Project:

It was assumed that there will be at least 30 days where marine traffic will be delayed due to construction of a new bridge, and demolition of the existing bridge superstructure and water piers. Barge mounted cranes would likely be required for both demolition of the existing bridges and construction of the new bridges. The presence of these barges would lead to limiting marine navigation during various periods of construction. The actual number of days will need to be determined during future development of a Bridge Replacement project.



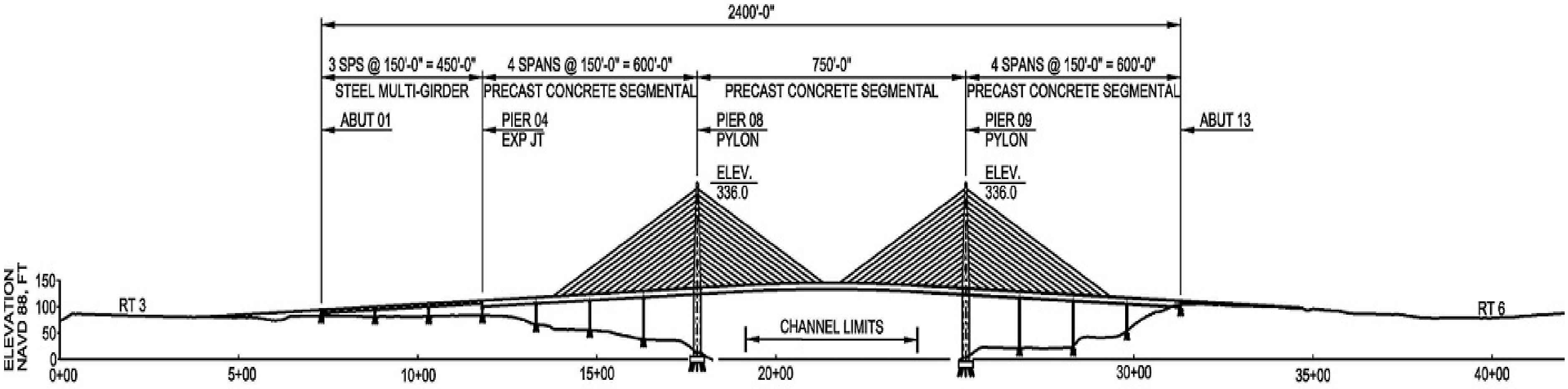
SECTION AT CONCRETE SPAN

SCALE: 3/16" = 1'-0"

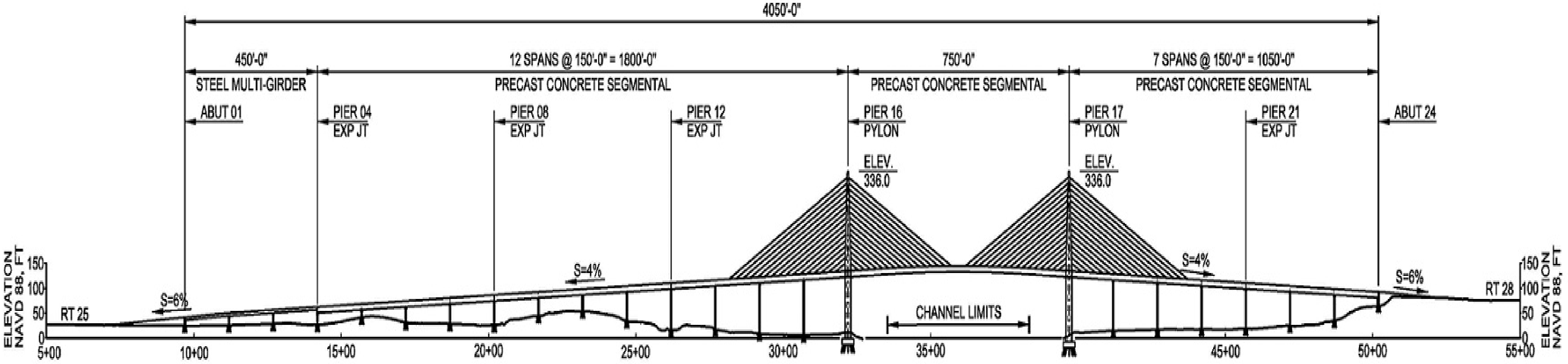


SECTION AT STEEL SPAN

SCALE: 3/16" = 1'-0"



SAGAMORE BRIDGE REPLACEMENT PROFILE



BOURNE BRIDGE REPLACEMENT PROFILE

8. STRUCTURAL RELIABILITY

a. Objective

This structural reliability analysis serves as the probabilistic basis for an economic analysis that drives the decision making process by demonstrating the best economic alternative for addressing the deteriorating performance of the ageing Bourne and Sagamore Bridges. This analysis was conducted in 2016, hence the reliability calculations are prepared for years 2016 to 2065, consistent with the prescribed 50-year service life for economic analysis. This period of analysis is suitable because the condition ratings for the Bourne and Sagamore bridges have not changed since 2014 for the Bourne Bridge and 2013 for the Sagamore Bridge. The condition ratings is what was used as the means of identifying a limit state of unsatisfactory performance.

b. Economic Alternatives

Three economic alternatives are identified for evaluation as follows:

(1) Base Condition. The Base Condition, synonymous with a "without project" condition, assumes that the bridges will continue to be operated efficiently and with due diligence for vehicular and marine safety. In the event of unsatisfactory performance of a bridge component, it is assumed that emergency funding will be made available to address the deficiency. This scenario portrays a condition where the reliability of the bridges is allowed to fall below the current condition, but that the bridge remains functional.

(2) Major Rehabilitation. This scenario assumes that all known structural deficiencies on both bridges will be addressed under a Major Rehabilitation Contract.

(3) Bridge Replacement. This scenario postulates that two new vehicular bridges will be constructed, one parallel to the existing Bourne Bridge and the other parallel to the existing Sagamore Bridge. The existing Bourne and Sagamore Bridges would remain in service until the new bridges are constructed.

c. Reliability Concepts

Reliability is defined as the probability that unsatisfactory performance will not occur. A "Limit State" is defined as the point at which unsatisfactory performance will occur or the engineering consequence will have some adverse economic impact. For this study, the limit state for unsatisfactory performance is defined as the physical condition where any of the bridges' critical elements is assigned a Condition Rating of 4 (Poor Condition) or less in accordance with protocols of the National Bridge Inspection Standard (NBIS).

Defining unsatisfactory performance based on the physical condition of the bridges using NBIS Condition Rating codes provides a viable way of determining a set of data points necessary for the regression analysis. USACE has historic data pertaining to the condition rating codes and this data can also be extrapolated for further analysis. In addition, this type of data is consistent with information in the national bridge inventory where data from similar types of bridges of similar age and environment can also be used for comparison purposes. The corrosion data reported in Section 6 above is ultimately related to the condition ratings through the performance of prior and subsequent Routine or In-Depth inspections of the bridges to assess the overall condition of the superstructure, deck, and substructure.

d. Deterioration Models

The overall reliability of the bridges is governed by three critical elements: superstructure, bridge deck, and substructure. Unsatisfactory performance of one or more of these critical elements would lead to unsatisfactory performance of the entire bridge. In order to assess the engineering reliability of the bridges, a probabilistic hazard function was developed for each of the three critical elements. For each critical element, a two-parameter (defined by a shape parameter and a scale parameter) Weibull Probability Distribution was developed to predict deteriorating bridge element performance over a fifty-year service life. The Weibull Probability Distribution is well accepted in academia and engineering literature as a methodology for assessing reliability and failure rates. Mathematical expressions for the Weibull Probability Distribution are as follows:

$F(t)$ = Cumulative Distribution Function = $1 - e^{[(-t/\eta)^{\beta}]}$

$h(t)$ = Annual Hazard (Failure) Rate = $(\beta/\eta)[(t/\eta)^{\beta-1}]$

$L(t)$ = Reliability Function = $1 - F(t)$

Where,

β = shape parameter

η = scale parameter

t = time

Calibration of the Weibull Probability Distribution for the superstructure and bridge deck was performed by regression analysis of data sets obtained from the National Bridge Inspection (NBI) database. The NBI database is the repository of information on all bridges in the nation and contains information on the year the bridge was built, the year the bridge was reconstructed, and summary condition ratings for the superstructure, bridge deck, and substructure.

For the superstructure and bridge deck, the NBI database was queried for bridges of similar construction and age to that of the Bourne and Sagamore Bridges located in New England, New York, and over the Chesapeake-Delaware Canal, which are geographic areas with similar environmental exposures. Where the NBI data indicated an entry for "Year Reconstructed," additional historical information was obtained by searching the internet for details of the reconstruction work. When reconstruction occurred, the bridges were generally verified or otherwise assumed to be in "Poor Condition." It is important to note that in the NBI database, an entry for "Year Reconstructed" is the date at which the rehabilitation work was completed. To calibrate the Weibull parameters, the following method was used to determine the time at which the bridge deteriorated to Poor Condition:

Time to Poor Condition = Year Reconstructed – Year Built – 5 Years

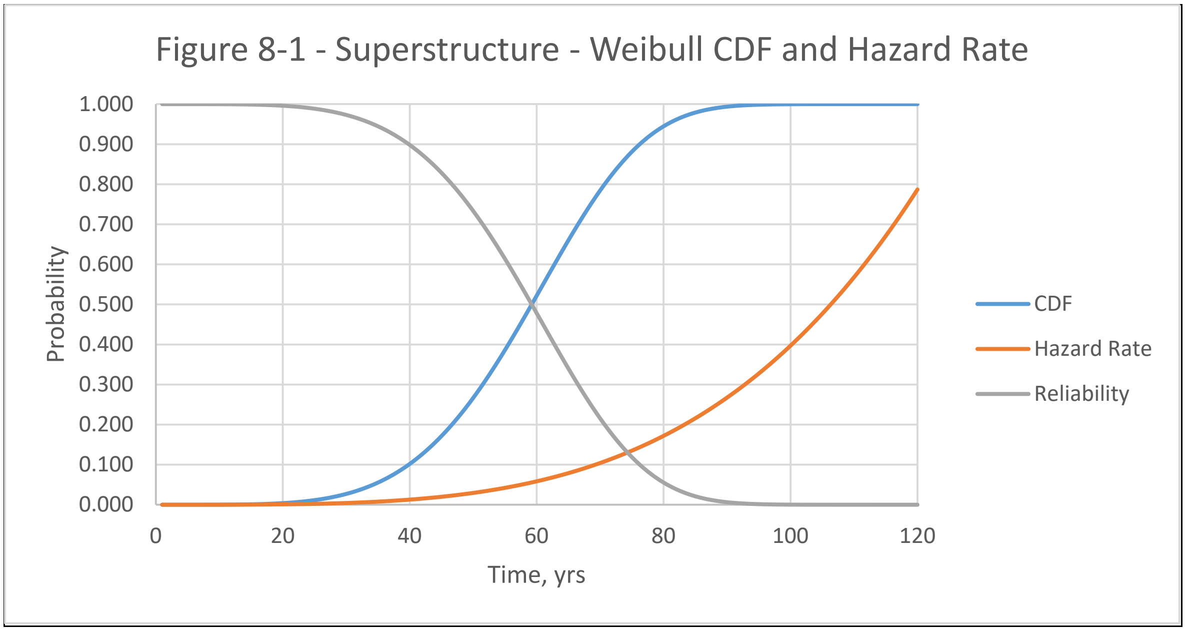
The five-year factor was adopted in the expression above as a reasonable estimate of the period it takes to program funding, perform design, and execute a remedial contract.

Data for substructure elements are not easily searchable in the NBI database. For this critical element, standard data points adopted by the U.S Army Corps of Engineers' Risk Management Center were used for the substructure deterioration model. These data points are contained in an electronic file titled “National Weibull Curve, Concrete A” and represent conglomerate data points for reinforced concrete locks, walls, and bridge piers.

The Weibull Distribution parameters used for each of the three critical elements, are summarized in the table below. The Weibull shape parameter, β, is also known as the Weibull slope. The value of β is equal to the slope of the line in a probability plot. If the Weibull scale parameter, η, is greater than 1, this indicates that the failure rate increases with time. This happens if there is an "aging" process, or parts that are more likely to fail as time goes on. These parameters were derived from the hazard function curves.

Weibull Cumulative Distribution Function (CDF) and hazard rates developed for superstructure, decks, and substructure are presented in Figures 8-1, 8-2, and 8-3, respectively. Weibull CDF is the probability of an event occurring within the time “t”. The hazard rate is a conditional failure rate in relation to the reliability of a system or component. The hazard functions are presented in tables 8-1 through 8-9 at the end of this section.

WEIBULL DISTRIBUTION PARAMETERS		
Bridge Element	Shape Parameter (β)	Scale Parameter (η)
Superstructure	4.752	63.97
Bridge Deck	4.909	59.73
Substructure	4.000	156.00



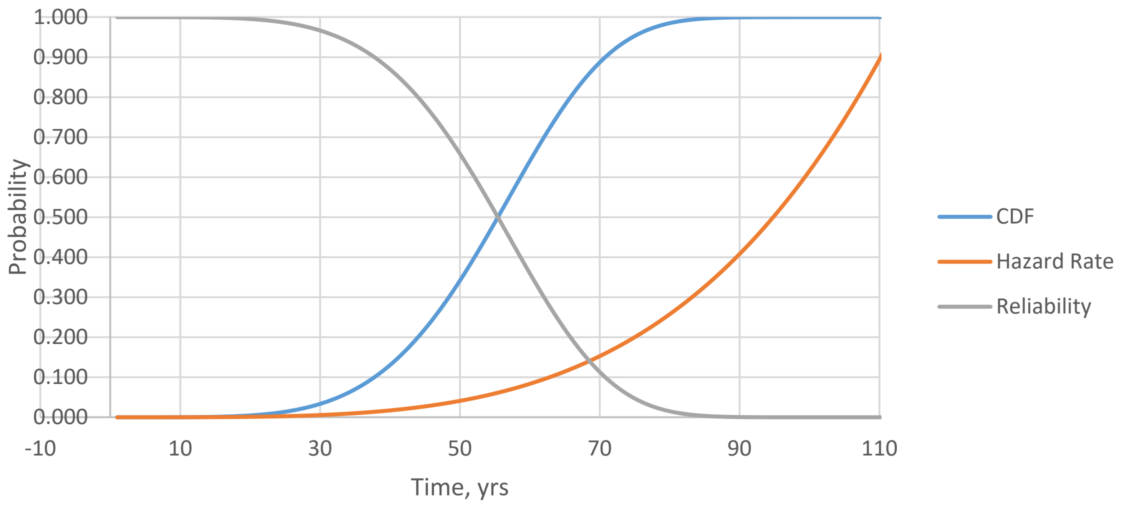


Figure 8-2 - Bridge Decks - Weibull CDF and Hazard Rate

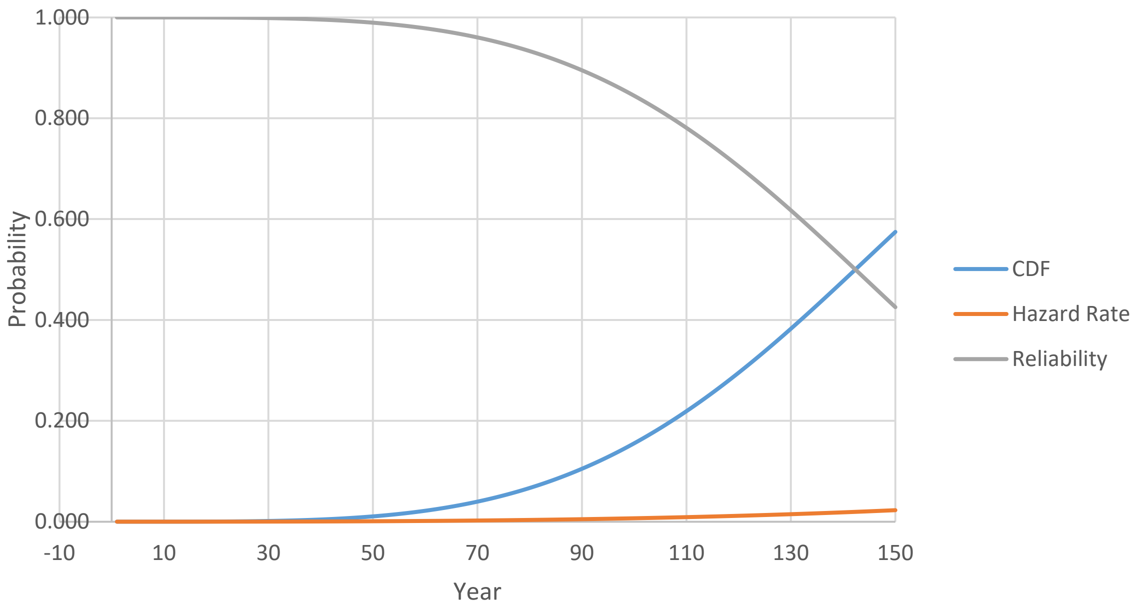


Figure 8-3 - Substructure - Weibull CDF and Hazard Rate

e. Reliability Calculations for the Base Condition

Major Rehabilitation of both the Bourne and Sagamore Bridges was completed circa 1981. The work consisted of replacement of the bridge deck with a concrete-filled steel grid, replacement and repairs to deteriorated stringers, replacement of hanger cables, repair of secondary members, replacement of corroded rivets and lacing bars, and painting of the superstructure. For development of the deterioration model, it is assumed that the rehabilitation of the superstructure extended the service life by twenty years, i.e. the time variable is reset to twenty years prior for years 1981 and beyond for purposes of computing the superstructure's reliability. Since the bridge deck was replaced completely as part of the major rehabilitation, the time variable is reset to zero in year 1981. No adjustment of the time variable for the substructure was made since only routine maintenance consisting of crack sealing and spall repairs has been performed over the life of the bridges. See Tables A-8-1, A-8-2, A-8-3 for the predicted reliability under the Base Condition for the superstructure, bridge deck, and substructure, respectively.

f. Reliability Calculations for Major Rehabilitation and Bridge Replacement Alternatives

For the Major Rehabilitation economic alternative, a postulated major rehabilitation in year 2016 is assumed to extend the service life of the superstructure and substructure by an additional twenty years and reset the time variable for the bridge deck to zero at the beginning of calendar year 2016 (assuming that deck again would be replaced completely). See Tables A-8-4, A-8-5, and A-8-6 for the predicted reliability under the Major Rehabilitation alternative for the superstructure, bridge deck, and substructure, respectively.

For the Bridge Replacement economic alternative, the time variables for computing the reliability of the superstructure, bridge deck, and substructure are all reset to zero at the beginning of calendar year 2016. See Tables A-8-7, A-8-8, and A-8-9 for the predicted reliability under the Bridge Replacement alternative for the superstructure, bridge deck, and substructure, respectively.

g. Consequence of Unsatisfactory Performance

The consequences of unsatisfactory performance, defined for this study as an NBI Condition rating equal to, or less than, 4 (Poor Condition) for the superstructure, bridge deck, or substructure on either bridge, are presented on an Event Tree for each critical element under each economic alternative. In addition to the contract costs for repair work, the economic factors associated with unsatisfactory performance predominantly are the delays to vehicular traffic and commercial marine vessels navigating the Cape Cod Canal.

All repair work on the superstructure and bridge deck require vehicular lane closures to facilitate contractor activities. Typically, these lane closures restrict travel to one lane in each direction. Historically, temporary lane closures have been in effect for a minimum of approximately nine months during the course of repair contracts.

As previously stated, full closure of the bridge will be required for shorter time periods to allow critical replacement of certain bridge components, such as interior gusset plates and floorbeams. It is anticipated that multiple bridge closure periods would be required over the course of a typical Major Rehabilitation project and each closure would probably be for a period of about 2 weeks. Multiple interior gusset plate and/or floorbeam replacements could occur during any given period of full bridge closure, but time and physical constraints would still result in the likelihood of multiple bridge closures over the course of a Major Rehabilitation project.

Repairs to the substructure would require closure or delays to commercial marine vessels in additional to limited vehicular lane closures. For this reliability study, the substructure components are limited to the bridge piers located in the waterway. The abutments for both bridges can accessed from land-based construction methods and would not impact marine vessels.

An Event Trees for each of the critical elements has been developed to portray the full range of consequences caused by incidents ranging from localized structural defects to the remote probability of catastrophic damage. Given that the Bourne and Sagamore Bridges were both opened to traffic in 1935, exposed to similar environmental and load conditions, and maintained at approximately the same intervals, the Event Trees account for the probability that a structural defect manifested on one bridge will dictate that similar repair work be performed on the sister bridge. See Figures A-8-4, A-8-5, and A-8-6 for the Event Trees for the superstructure, bridge deck, and substructure, respectively.

h. Results of the Reliability Analysis

The cumulative reliability of the superstructure, bridge deck, and substructure for each of the alternatives at the end of the 50-year period (2016-2065) for economic evaluation is summarized in the table below. These cumulative reliabilities are used as a basis of comparison of the three alternatives, not as the basis for initiating any specific project or type of work.

CUMULATIVE RELIABILITY IN 2065

Bridge Element	Base Condition	Major Rehabilitation	Bridge Replacement
Superstructure	0.000	0.006	0.733
Bridge Deck	0.005	0.659	0.659
Substructure	0.617	0.781	0.990

A review of the predicted reliabilities in this table indicate that the Base Condition alternative yields the lowest reliability for all three of the critical elements. The deterioration model predicts with near certainty that both superstructure and bridge deck will be performing unsatisfactorily at the end of the 50-year period of evaluation.

The Major Rehabilitation alternative predicts reliabilities that are an improvement over the Base Condition, but the superstructure reliability of 0.006 makes this alternative a poor investment option.

The Bridge Replacement alternative offers the highest reliability of the three economic alternatives under consideration. This alternative will allow the U.S Army Corps of Engineers to fulfill its responsibility to provide continued safe passage for vehicular and marine traffic.

j. Structural Conclusion.

This engineering reliability analysis shows that the Bridge Replacement alternative offers the highest reliability of these three alternatives.

Providing a replacement for the existing spans in-kind with respect to the number of through traffic lanes would not conform to current design guidance for bridges and highways. For this reason, providing new bridges without auxiliary lanes would not be consistent with best practices for traffic safety, and any plan for a 4-lane bridge will not be carried forward into a detailed analysis.

The two existing bridges with their four through traffic lanes were designed and built in the 1930s to serve far lower traffic volumes than those served by the bridges today. Modern highway design guidance, including AASHTO highway and bridge design specifications and MassDOT design guidance require including auxiliary lanes for entering and exiting traffic to transition into or out of through traffic safely.

Furthermore, qualitatively, a Major Rehabilitation project will have significant socio-economic impacts on the surrounding region due to long-term ongoing traffic delays and disruptions. The Base Condition, or without project, alternative, would likely create troublesome situations during the 50-year study period. For example, at some point the bridges will need to have weight restrictions, and likely undergo emergency structural repairs, which may or may not have an impact on load postings. Unplanned or emergency maintenance is costly and could lead to significant traffic issues at uncertain times of the year, possibly even during the busiest summer months for tourism. This would have a significant economic impact on the region’s businesses.

Despite their testament to engineering accomplishments of the 19th Century and aesthetic charm, these 80 year old steel bridges are beyond their functional service life. While both of these bridges can be maintained to prolong their overall structural integrity, both are already functionally obsolete. In addition, both bridges will likely need load postings and truck traffic restrictions at some point due to corrosion and deterioration causing a decrease of structural capacity of various steel members, even if the bridges are maintained in a state of good repair. The Bourne and Sagamore bridges are not suitable for continued operation as a primary link in the highway system of southeastern Massachusetts and Cape Cod.

TABLE A-8-1: HAZARD FUNCTION FOR SUPERSTRUCTURE-BASE CONDITION

Years 2016 to 2065

Weibull Distribution:
Shape Parameter= 4.752
Scale Parameter= 63.97

Where,
h(t) = Failure Rate Function
F(t) = Cumulative Distribution Function
L(t) = Reliability Function
= 1 - F(t)

YEAR	Time *	Weibull	Weibull	Weibull
	t	h(t)	F(t)	L(t)
2016	61	0.0621	0.5497	0.4503
2017	62	0.0661	0.5776	0.4224
2018	63	0.0701	0.6054	0.3946
2019	64	0.0744	0.6329	0.3671
2020	65	0.0789	0.6600	0.3400
2021	66	0.0835	0.6865	0.3135
2022	67	0.0884	0.7123	0.2877
2023	68	0.0934	0.7373	0.2627
2024	69	0.0987	0.7614	0.2386
2025	70	0.1042	0.7844	0.2156
2026	71	0.1098	0.8063	0.1937
2027	72	0.1158	0.8269	0.1731
2028	73	0.1219	0.8463	0.1537
2029	74	0.1283	0.8644	0.1356
2030	75	0.1349	0.8811	0.1189
2031	76	0.1418	0.8965	0.1035
2032	77	0.1489	0.9105	0.0895
2033	78	0.1563	0.9231	0.0769
2034	79	0.1640	0.9345	0.0655
2035	80	0.1719	0.9446	0.0554
2036	81	0.1801	0.9536	0.0464
2037	82	0.1886	0.9614	0.0386
2038	83	0.1974	0.9682	0.0318
2039	84	0.2064	0.9740	0.0260
2040	85	0.2158	0.9789	0.0211
2041	86	0.2255	0.9831	0.0169
2042	87	0.2355	0.9866	0.0134
2043	88	0.2458	0.9895	0.0105
2044	89	0.2564	0.9918	0.0082
2045	90	0.2674	0.9937	0.0063
2046	91	0.2787	0.9952	0.0048
2047	92	0.2904	0.9964	0.0036
2048	93	0.3024	0.9973	0.0027
2049	94	0.3148	0.9980	0.0020
2050	95	0.3276	0.9986	0.0014
2051	96	0.3407	0.9990	0.0010
2052	97	0.3542	0.9993	0.0007
2053	98	0.3681	0.9995	0.0005
2054	99	0.3824	0.9997	0.0003
2055	100	0.3971	0.9998	0.0002
2056	101	0.4122	0.9998	0.0002
2057	102	0.4277	0.9999	0.0001
2058	103	0.4437	0.9999	0.0001
2059	104	0.4600	1.0000	0.0000
2060	105	0.4768	1.0000	0.0000
2061	106	0.4941	1.0000	0.0000
2062	107	0.5118	1.0000	0.0000
2063	108	0.5300	1.0000	0.0000
2064	109	0.5487	1.0000	0.0000
2065	110	0.5678	1.0000	0.0000

* Note: The bridges were constructed in 1935. Major Rehabilitation of the superstructures was performed in 1981.
This deterioration model assumes that the Major Rehabilitation extended the service life by 20 years.

TABLE A-8-2: HAZARD FUNCTION FOR BRIDGE DECK-BASE CONDITION

Years 2016 to 2065

Weibull Distribution:
Shape Parameter= 4.909
Scale Parameter= 59.73

Where,
h(t) = Failure Rate Function
F(t) = Cumulative Distribution Function
L(t) = Reliability Function
= 1 - F(t)

YEAR	Time *	Weibull	Weibull	Weibull
	t	h(t)	F(t)	L(t)
2016	35	0.0102	0.0700	0.9300
2017	36	0.0114	0.0799	0.9201
2018	37	0.0126	0.0909	0.9091
2019	38	0.0140	0.1029	0.8971
2020	39	0.0155	0.1161	0.8839
2021	40	0.0171	0.1304	0.8696
2022	41	0.0189	0.1459	0.8541
2023	42	0.0207	0.1626	0.8374
2024	43	0.0227	0.1806	0.8194
2025	44	0.0249	0.1999	0.8001
2026	45	0.0272	0.2205	0.7795
2027	46	0.0296	0.2423	0.7577
2028	47	0.0322	0.2653	0.7347
2029	48	0.0350	0.2896	0.7104
2030	49	0.0379	0.3150	0.6850
2031	50	0.0410	0.3415	0.6585
2032	51	0.0443	0.3690	0.6310
2033	52	0.0478	0.3974	0.6026
2034	53	0.0515	0.4266	0.5734
2035	54	0.0554	0.4564	0.5436
2036	55	0.0595	0.4867	0.5133
2037	56	0.0639	0.5174	0.4826
2038	57	0.0685	0.5483	0.4517
2039	58	0.0733	0.5792	0.4208
2040	59	0.0783	0.6099	0.3901
2041	60	0.0836	0.6403	0.3597
2042	61	0.0892	0.6700	0.3300
2043	62	0.0951	0.6991	0.3009
2044	63	0.1012	0.7272	0.2728
2045	64	0.1077	0.7543	0.2457
2046	65	0.1144	0.7801	0.2199
2047	66	0.1214	0.8045	0.1955
2048	67	0.1288	0.8275	0.1725
2049	68	0.1364	0.8489	0.1511
2050	69	0.1445	0.8687	0.1313
2051	70	0.1528	0.8868	0.1132
2052	71	0.1615	0.9033	0.0967
2053	72	0.1706	0.9181	0.0819
2054	73	0.1800	0.9313	0.0687
2055	74	0.1899	0.9429	0.0571
2056	75	0.2001	0.9530	0.0470
2057	76	0.2107	0.9617	0.0383
2058	77	0.2218	0.9692	0.0308
2059	78	0.2333	0.9754	0.0246
2060	79	0.2452	0.9807	0.0193
2061	80	0.2575	0.9850	0.0150
2062	81	0.2704	0.9884	0.0116
2063	82	0.2836	0.9912	0.0088
2064	83	0.2974	0.9935	0.0065
2065	84	0.3117	0.9952	0.0048

* Note: Bridge decks were replaced during the 1981 Major Rehabilitation.

TABLE A-8-3: HAZARD FUNCTION FOR SUBSTRUCTURE-BASE CONDITION

Years 2016 to 2065

Weibull Distribution:
Shape Parameter= 4
Scale Parameter= 156

Where,
h(t) = Failure Rate Function
F(t) = Cumulative Distribution Function
L(t) = Reliability Function
= 1 - F(t)

YEAR	Time *	Weibull	Weibull	Weibull
	t	h(t)	F(t)	L(t)
2016	81	0.0036	0.0701	0.9299
2017	82	0.0037	0.0735	0.9265
2018	83	0.0039	0.0770	0.9230
2019	84	0.0040	0.0806	0.9194
2020	85	0.0041	0.0844	0.9156
2021	86	0.0043	0.0882	0.9118
2022	87	0.0044	0.0922	0.9078
2023	88	0.0046	0.0963	0.9037
2024	89	0.0048	0.1005	0.8995
2025	90	0.0049	0.1049	0.8951
2026	91	0.0051	0.1093	0.8907
2027	92	0.0053	0.1139	0.8861
2028	93	0.0054	0.1187	0.8813
2029	94	0.0056	0.1235	0.8765
2030	95	0.0058	0.1285	0.8715
2031	96	0.0060	0.1336	0.8664
2032	97	0.0062	0.1388	0.8612
2033	98	0.0064	0.1442	0.8558
2034	99	0.0066	0.1497	0.8503
2035	100	0.0068	0.1554	0.8446
2036	101	0.0070	0.1611	0.8389
2037	102	0.0072	0.1670	0.8330
2038	103	0.0074	0.1731	0.8269
2039	104	0.0076	0.1792	0.8208
2040	105	0.0078	0.1855	0.8145

YEAR	Time	Weibull	Weibull	Weibull
	t	h(t)	F(t)	L(t)
2041	106	0.0080	0.1920	0.8080
2042	107	0.0083	0.1985	0.8015
2043	108	0.0085	0.2052	0.7948
2044	109	0.0087	0.2121	0.7879
2045	110	0.0090	0.2190	0.7810
2046	111	0.0092	0.2261	0.7739
2047	112	0.0095	0.2333	0.7667
2048	113	0.0097	0.2407	0.7593
2049	114	0.0100	0.2481	0.7519
2050	115	0.0103	0.2557	0.7443
2051	116	0.0105	0.2634	0.7366
2052	117	0.0108	0.2712	0.7288
2053	118	0.0111	0.2792	0.7208
2054	119	0.0114	0.2872	0.7128
2055	120	0.0117	0.2954	0.7046
2056	121	0.0120	0.3037	0.6963
2057	122	0.0123	0.3121	0.6879
2058	123	0.0126	0.3206	0.6794
2059	124	0.0129	0.3291	0.6709
2060	125	0.0132	0.3378	0.6622
2061	126	0.0135	0.3466	0.6534
2062	127	0.0138	0.3555	0.6445
2063	128	0.0142	0.3644	0.6356
2064	129	0.0145	0.3735	0.6265
2065	130	0.0148	0.3826	0.6174

* Note: The bridges were constructed in 1935. Maintenance of the reinforced concrete substructures has been performed on an as-needed basis.
Repair work consisted of crack sealing and spall repairs.

TABLE A-8-4: HAZARD FUNCTION FOR SUPERSTRUCTURE-MAJOR REHABILITATION

Years 2016 to 2065

Weibull Distribution:
Shape Parameter= 4.752
Scale Parameter= 63.97

Where,
h(t) = Failure Rate Function
F(t) = Cumulative Distribution Function
L(t) = Reliability Function
= 1 - F(t)

YEAR	Time *	Weibull	Weibull	Weibull
	t	h(t)	F(t)	L(t)
2016	41	0.0140	0.1138	0.8862
2017	42	0.0153	0.1267	0.8733
2018	43	0.0167	0.1405	0.8595
2019	44	0.0182	0.1554	0.8446
2020	45	0.0198	0.1714	0.8286
2021	46	0.0216	0.1883	0.8117
2022	47	0.0234	0.2063	0.7937
2023	48	0.0253	0.2254	0.7746
2024	49	0.0273	0.2455	0.7545
2025	50	0.0295	0.2666	0.7334
2026	51	0.0317	0.2887	0.7113
2027	52	0.0341	0.3118	0.6882
2028	53	0.0367	0.3357	0.6643
2029	54	0.0393	0.3605	0.6395
2030	55	0.0421	0.3860	0.6140
2031	56	0.0451	0.4122	0.5878
2032	57	0.0482	0.4390	0.5610
2033	58	0.0514	0.4662	0.5338
2034	59	0.0548	0.4938	0.5062
2035	60	0.0584	0.5217	0.4783
2036	61	0.0621	0.5497	0.4503
2037	62	0.0661	0.5776	0.4224
2038	63	0.0701	0.6054	0.3946
2039	64	0.0744	0.6329	0.3671
2040	65	0.0789	0.6600	0.3400
2041	66	0.0835	0.6865	0.3135
2042	67	0.0884	0.7123	0.2877
2043	68	0.0934	0.7373	0.2627
2044	69	0.0987	0.7614	0.2386
2045	70	0.1042	0.7844	0.2156
2046	71	0.1098	0.8063	0.1937
2047	72	0.1158	0.8269	0.1731
2048	73	0.1219	0.8463	0.1537
2049	74	0.1283	0.8644	0.1356
2050	75	0.1349	0.8811	0.1189
2051	76	0.1418	0.8965	0.1035
2052	77	0.1489	0.9105	0.0895
2053	78	0.1563	0.9231	0.0769
2054	79	0.1640	0.9345	0.0655
2055	80	0.1719	0.9446	0.0554
2056	81	0.1801	0.9536	0.0464
2057	82	0.1886	0.9614	0.0386
2058	83	0.1974	0.9682	0.0318
2059	84	0.2064	0.9740	0.0260
2060	85	0.2158	0.9789	0.0211
2061	86	0.2255	0.9831	0.0169
2062	87	0.2355	0.9866	0.0134
2063	88	0.2458	0.9895	0.0105
2064	89	0.2564	0.9918	0.0082
2065	90	0.2674	0.9937	0.0063

* Note: The bridges were constructed in 1935. Major Rehabilitation of the superstructures was performed in 1981. This deterioration model assumes that the 1981 Major Rehabilitation extended the service life by 20 years and a postulated 2016 Major Rehabilitation would extend the service life by an additional 20 years.

TABLE A-8-5: HAZARD FUNCTION FOR BRIDGE DECK-MAJOR REHABILITATION OR BRIDGE REPLACEMENT

Years 2016 to 2065

Weibull Distribution:
Shape Parameter= 4.909
Scale Parameter= 59.73

Where,
h(t) = Failure Rate Function
F(t) = Cumulative Distribution Function
L(t) = Reliability Function
= 1 - F(t)

YEAR	Time	Weibull	Weibull	Weibull
	t	h(t)	F(t)	L(t)
2016	1	0.0000	0.0000	1.0000
2017	2	0.0000	0.0000	1.0000
2018	3	0.0000	0.0000	1.0000
2019	4	0.0000	0.0000	1.0000
2020	5	0.0000	0.0000	1.0000
2021	6	0.0000	0.0000	1.0000
2022	7	0.0000	0.0000	1.0000
2023	8	0.0000	0.0001	0.9999
2024	9	0.0001	0.0001	0.9999
2025	10	0.0001	0.0002	0.9998
2026	11	0.0001	0.0002	0.9998
2027	12	0.0002	0.0004	0.9996
2028	13	0.0002	0.0006	0.9994
2029	14	0.0003	0.0008	0.9992
2030	15	0.0004	0.0011	0.9989
2031	16	0.0005	0.0016	0.9984
2032	17	0.0006	0.0021	0.9979
2033	18	0.0008	0.0028	0.9972
2034	19	0.0009	0.0036	0.9964
2035	20	0.0011	0.0046	0.9954
2036	21	0.0014	0.0059	0.9941
2037	22	0.0017	0.0074	0.9926
2038	23	0.0020	0.0092	0.9908
2039	24	0.0023	0.0113	0.9887
2040	25	0.0027	0.0138	0.9862
2041	26	0.0032	0.0167	0.9833
2042	27	0.0037	0.0201	0.9799
2043	28	0.0043	0.0240	0.9760
2044	29	0.0049	0.0284	0.9716
2045	30	0.0056	0.0335	0.9665
2046	31	0.0063	0.0392	0.9608
2047	32	0.0072	0.0456	0.9544
2048	33	0.0081	0.0529	0.9471
2049	34	0.0091	0.0610	0.9390
2050	35	0.0102	0.0700	0.9300
2051	36	0.0114	0.0799	0.9201
2052	37	0.0126	0.0909	0.9091
2053	38	0.0140	0.1029	0.8971
2054	39	0.0155	0.1161	0.8839
2055	40	0.0171	0.1304	0.8696
2056	41	0.0189	0.1459	0.8541
2057	42	0.0207	0.1626	0.8374
2058	43	0.0227	0.1806	0.8194
2059	44	0.0249	0.1999	0.8001
2060	45	0.0272	0.2205	0.7795
2061	46	0.0296	0.2423	0.7577
2062	47	0.0322	0.2653	0.7347
2063	48	0.0350	0.2896	0.7104
2064	49	0.0379	0.3150	0.6850
2065	50	0.0410	0.3415	0.6585

TABLE A-8-6: HAZARD FUNCTION FOR SUBSTRUCTURE-MAJOR REHABILITATION

Years 2016 to 2065

Weibull Distribution:
Shape Parameter= 4
Scale Parameter= 156

Where,
h(t) = Failure Rate Function
F(t) = Cumulative Distribution Function
L(t) = Reliability Function
= 1 - F(t)

YEAR	Time *	Weibull	Weibull	Weibull
	t	h(t)	F(t)	L(t)
2016	61	0.0015	0.0231	0.9769
2017	62	0.0016	0.0246	0.9754
2018	63	0.0017	0.0262	0.9738
2019	64	0.0018	0.0279	0.9721
2020	65	0.0019	0.0297	0.9703
2021	66	0.0019	0.0315	0.9685
2022	67	0.0020	0.0335	0.9665
2023	68	0.0021	0.0355	0.9645
2024	69	0.0022	0.0376	0.9624
2025	70	0.0023	0.0397	0.9603
2026	71	0.0024	0.0420	0.9580
2027	72	0.0025	0.0444	0.9556
2028	73	0.0026	0.0468	0.9532
2029	74	0.0027	0.0494	0.9506
2030	75	0.0028	0.0520	0.9480
2031	76	0.0030	0.0548	0.9452
2032	77	0.0031	0.0576	0.9424
2033	78	0.0032	0.0606	0.9394
2034	79	0.0033	0.0637	0.9363
2035	80	0.0035	0.0668	0.9332
2036	81	0.0036	0.0701	0.9299
2037	82	0.0037	0.0735	0.9265
2038	83	0.0039	0.0770	0.9230
2039	84	0.0040	0.0806	0.9194
2040	85	0.0041	0.0844	0.9156

YEAR	Time	Weibull	Weibull	Weibull
	t	h(t)	F(t)	L(t)
2041	86	0.0043	0.0882	0.9118
2042	87	0.0044	0.0922	0.9078
2043	88	0.0046	0.0963	0.9037
2044	89	0.0048	0.1005	0.8995
2045	90	0.0049	0.1049	0.8951
2046	91	0.0051	0.1093	0.8907
2047	92	0.0053	0.1139	0.8861
2048	93	0.0054	0.1187	0.8813
2049	94	0.0056	0.1235	0.8765
2050	95	0.0058	0.1285	0.8715
2051	96	0.0060	0.1336	0.8664
2052	97	0.0062	0.1388	0.8612
2053	98	0.0064	0.1442	0.8558
2054	99	0.0066	0.1497	0.8503
2055	100	0.0068	0.1554	0.8446
2056	101	0.0070	0.1611	0.8389
2057	102	0.0072	0.1670	0.8330
2058	103	0.0074	0.1731	0.8269
2059	104	0.0076	0.1792	0.8208
2060	105	0.0078	0.1855	0.8145
2061	106	0.0080	0.1920	0.8080
2062	107	0.0083	0.1985	0.8015
2063	108	0.0085	0.2052	0.7948
2064	109	0.0087	0.2121	0.7879
2065	110	0.0090	0.2190	0.7810

* Note: The bridges were built in 1935 and maintenance of the reinforced concrete substructure has been performed as needed.
This deterioration model assumes that a Major Rehabilitation would extent the service life of the substructure by 20 years.

TABLE A-8-7: HAZARD FUNCTION FOR SUPERSTRUCTURE-BRIDGE REPLACEMENT

Years 2016 to 2065

Weibull Distribution:

Shape Parameter=	4.752
Scale Parameter=	63.97

Where,
h(t) = Failure Rate Function
F(t) = Cumulative Distribution Function
L(t) = Reliability Function
= 1 - F(t)

YEAR	Time	Weibull	Weibull	Weibull
	t	h(t)	F(t)	L(t)
2016	1	0.0000	0.0000	1.0000
2017	2	0.0000	0.0000	1.0000
2018	3	0.0000	0.0000	1.0000
2019	4	0.0000	0.0000	1.0000
2020	5	0.0000	0.0000	1.0000
2021	6	0.0000	0.0000	1.0000
2022	7	0.0000	0.0000	1.0000
2023	8	0.0000	0.0001	0.9999
2024	9	0.0000	0.0001	0.9999
2025	10	0.0001	0.0001	0.9999
2026	11	0.0001	0.0002	0.9998
2027	12	0.0001	0.0004	0.9996
2028	13	0.0002	0.0005	0.9995
2029	14	0.0002	0.0007	0.9993
2030	15	0.0003	0.0010	0.9990
2031	16	0.0004	0.0014	0.9986
2032	17	0.0005	0.0018	0.9982
2033	18	0.0006	0.0024	0.9976
2034	19	0.0008	0.0031	0.9969
2035	20	0.0009	0.0040	0.9960
2036	21	0.0011	0.0050	0.9950
2037	22	0.0014	0.0062	0.9938
2038	23	0.0016	0.0077	0.9923
2039	24	0.0019	0.0094	0.9906
2040	25	0.0022	0.0114	0.9886
2041	26	0.0025	0.0138	0.9862
2042	27	0.0029	0.0165	0.9835
2043	28	0.0033	0.0195	0.9805
2044	29	0.0038	0.0230	0.9770
2045	30	0.0043	0.0270	0.9730
2046	31	0.0049	0.0315	0.9685
2047	32	0.0055	0.0365	0.9635
2048	33	0.0062	0.0421	0.9579
2049	34	0.0069	0.0484	0.9516
2050	35	0.0077	0.0553	0.9447
2051	36	0.0086	0.0630	0.9370
2052	37	0.0095	0.0715	0.9285
2053	38	0.0105	0.0807	0.9193
2054	39	0.0116	0.0908	0.9092
2055	40	0.0128	0.1018	0.8982
2056	41	0.0140	0.1138	0.8862
2057	42	0.0153	0.1267	0.8733
2058	43	0.0167	0.1405	0.8595
2059	44	0.0182	0.1554	0.8446
2060	45	0.0198	0.1714	0.8286
2061	46	0.0216	0.1883	0.8117
2062	47	0.0234	0.2063	0.7937
2063	48	0.0253	0.2254	0.7746
2064	49	0.0273	0.2455	0.7545
2065	50	0.0295	0.2666	0.7334

TABLE A-8-8: HAZARD FUNCTION FOR BRIDGE DECK-MAJOR REHABILITATION OR BRIDGE REPLACEMENT

Years 2016 to 2065

Weibull Distribution:
Shape Parameter= 4.909
Scale Parameter= 59.73

Where,
h(t) = Failure Rate Function
F(t) = Cumulative Distribution Function
L(t) = Reliability Function
= 1 - F(t)

YEAR	Time	Weibull	Weibull	Weibull
	t	h(t)	F(t)	L(t)
2016	1	0.0000	0.0000	1.0000
2017	2	0.0000	0.0000	1.0000
2018	3	0.0000	0.0000	1.0000
2019	4	0.0000	0.0000	1.0000
2020	5	0.0000	0.0000	1.0000
2021	6	0.0000	0.0000	1.0000
2022	7	0.0000	0.0000	1.0000
2023	8	0.0000	0.0001	0.9999
2024	9	0.0001	0.0001	0.9999
2025	10	0.0001	0.0002	0.9998
2026	11	0.0001	0.0002	0.9998
2027	12	0.0002	0.0004	0.9996
2028	13	0.0002	0.0006	0.9994
2029	14	0.0003	0.0008	0.9992
2030	15	0.0004	0.0011	0.9989
2031	16	0.0005	0.0016	0.9984
2032	17	0.0006	0.0021	0.9979
2033	18	0.0008	0.0028	0.9972
2034	19	0.0009	0.0036	0.9964
2035	20	0.0011	0.0046	0.9954
2036	21	0.0014	0.0059	0.9941
2037	22	0.0017	0.0074	0.9926
2038	23	0.0020	0.0092	0.9908
2039	24	0.0023	0.0113	0.9887
2040	25	0.0027	0.0138	0.9862

YEAR	Time	Weibull	Weibull	Weibull
	t	h(t)	F(t)	L(t)
2041	26	0.0032	0.0167	0.9833
2042	27	0.0037	0.0201	0.9799
2043	28	0.0043	0.0240	0.9760
2044	29	0.0049	0.0284	0.9716
2045	30	0.0056	0.0335	0.9665
2046	31	0.0063	0.0392	0.9608
2047	32	0.0072	0.0456	0.9544
2048	33	0.0081	0.0529	0.9471
2049	34	0.0091	0.0610	0.9390
2050	35	0.0102	0.0700	0.9300
2051	36	0.0114	0.0799	0.9201
2052	37	0.0126	0.0909	0.9091
2053	38	0.0140	0.1029	0.8971
2054	39	0.0155	0.1161	0.8839
2055	40	0.0171	0.1304	0.8696
2056	41	0.0189	0.1459	0.8541
2057	42	0.0207	0.1626	0.8374
2058	43	0.0227	0.1806	0.8194
2059	44	0.0249	0.1999	0.8001
2060	45	0.0272	0.2205	0.7795
2061	46	0.0296	0.2423	0.7577
2062	47	0.0322	0.2653	0.7347
2063	48	0.0350	0.2896	0.7104
2064	49	0.0379	0.3150	0.6850
2065	50	0.0410	0.3415	0.6585

TABLE A-8-9: HAZARD FUNCTION FOR SUBSTRUCTURE-BRIDGE REPLACEMENT

Years 2016 to 2065

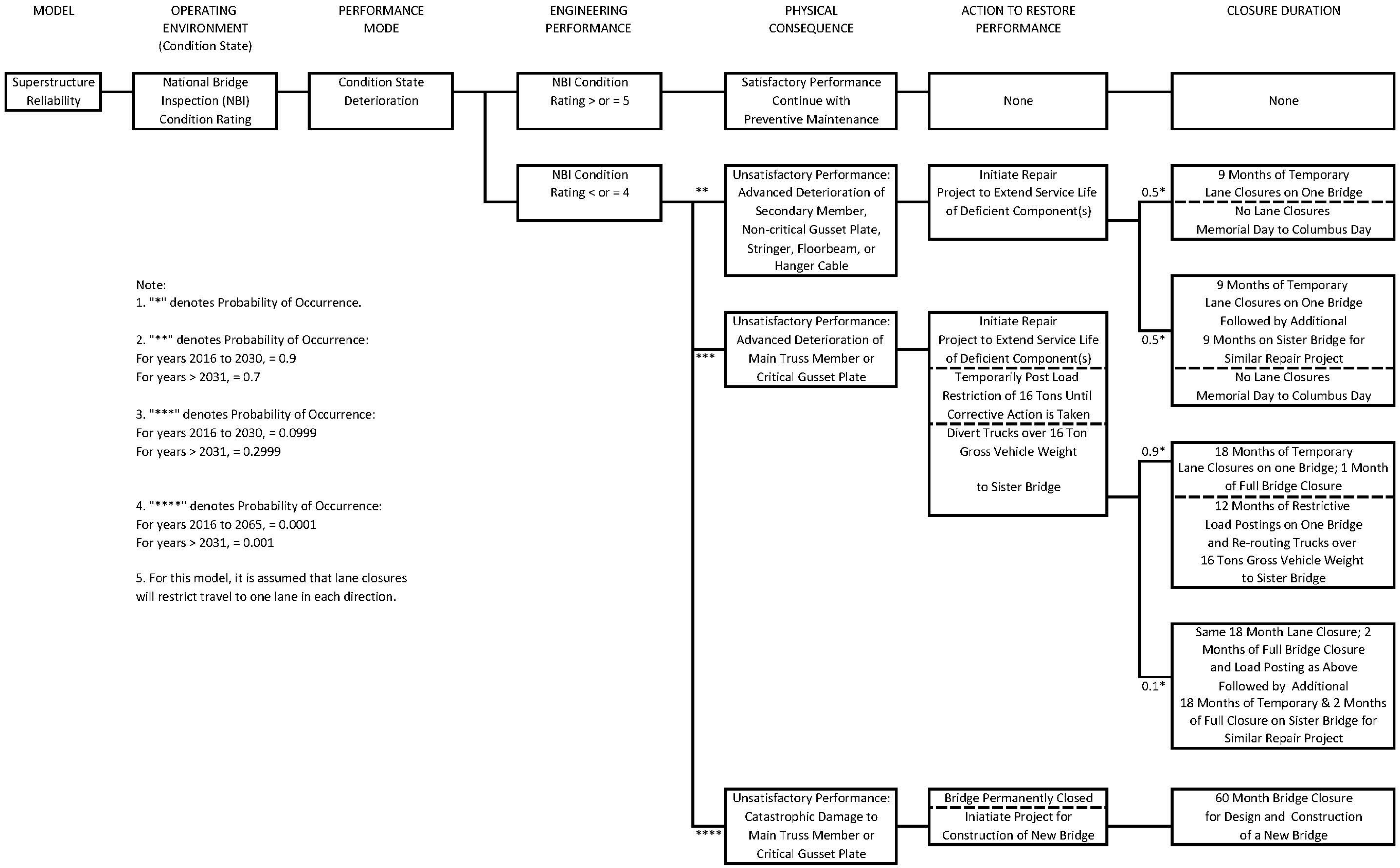
Weibull Distribution:

Shape Parameter=	4
Scale Parameter=	156

Where,
h(t) = Failure Rate Function
F(t) = Cumulative Distribution Function
L(t) = Reliability Function
= 1 - F(t)

YEAR	Time	Weibull	Weibull	Weibull
	t	h(t)	F(t)	L(t)
2016	1	0.0000	0.0000	1.0000
2017	2	0.0000	0.0000	1.0000
2018	3	0.0000	0.0000	1.0000
2019	4	0.0000	0.0000	1.0000
2020	5	0.0000	0.0000	1.0000
2021	6	0.0000	0.0000	1.0000
2022	7	0.0000	0.0000	1.0000
2023	8	0.0000	0.0000	1.0000
2024	9	0.0000	0.0000	1.0000
2025	10	0.0000	0.0000	1.0000
2026	11	0.0000	0.0000	1.0000
2027	12	0.0000	0.0000	1.0000
2028	13	0.0000	0.0000	1.0000
2029	14	0.0000	0.0001	0.9999
2030	15	0.0000	0.0001	0.9999
2031	16	0.0000	0.0001	0.9999
2032	17	0.0000	0.0001	0.9999
2033	18	0.0000	0.0002	0.9998
2034	19	0.0000	0.0002	0.9998
2035	20	0.0001	0.0003	0.9997
2036	21	0.0001	0.0003	0.9997
2037	22	0.0001	0.0004	0.9996
2038	23	0.0001	0.0005	0.9995
2039	24	0.0001	0.0006	0.9994
2040	25	0.0001	0.0007	0.9993

YEAR	Time	Weibull	Weibull	Weibull
	t	h(t)	F(t)	L(t)
2041	26	0.0001	0.0008	0.9992
2042	27	0.0001	0.0009	0.9991
2043	28	0.0001	0.0010	0.9990
2044	29	0.0002	0.0012	0.9988
2045	30	0.0002	0.0014	0.9986
2046	31	0.0002	0.0016	0.9984
2047	32	0.0002	0.0018	0.9982
2048	33	0.0002	0.0020	0.9980
2049	34	0.0003	0.0023	0.9977
2050	35	0.0003	0.0025	0.9975
2051	36	0.0003	0.0028	0.9972
2052	37	0.0003	0.0032	0.9968
2053	38	0.0004	0.0035	0.9965
2054	39	0.0004	0.0039	0.9961
2055	40	0.0004	0.0043	0.9957
2056	41	0.0005	0.0048	0.9952
2057	42	0.0005	0.0052	0.9948
2058	43	0.0005	0.0058	0.9942
2059	44	0.0006	0.0063	0.9937
2060	45	0.0006	0.0069	0.9931
2061	46	0.0007	0.0075	0.9925
2062	47	0.0007	0.0082	0.9918
2063	48	0.0007	0.0089	0.9911
2064	49	0.0008	0.0097	0.9903
2065	50	0.0008	0.0105	0.9895


MODEL
OPERATING ENVIRONMENT (Condition State)
PERFORMANCE MODE
ENGINEERING PERFORMANCE
PHYSICAL CONSEQUENCE
ACTION TO RESTORE PERFORMANCE
CLOSURE DURATION
Superstructure Reliability
National Bridge Inspection (NBI) Condition Rating
Condition State Deterioration
NBI Condition Rating > or = 5
Satisfactory Performance Continue with Preventive Maintenance
None
None
NBI Condition Rating < or = 4
**
Unsatisfactory Performance: Advanced Deterioration of Secondary Member, Non-critical Gusset Plate, Stringer, Floorbeam, or Hanger Cable
Initiate Repair Project to Extend Service Life of Deficient Component(s)
0.5*
9 Months of Temporary Lane Closures on One Bridge
No Lane Closures Memorial Day to Columbus Day
0.5*
9 Months of Temporary Lane Closures on One Bridge Followed by Additional 9 Months on Sister Bridge for Similar Repair Project
No Lane Closures Memorial Day to Columbus Day
***
Unsatisfactory Performance: Advanced Deterioration of Main Truss Member or Critical Gusset Plate
Initiate Repair Project to Extend Service Life of Deficient Component(s)
Temporarily Post Load Restriction of 16 Tons Until Corrective Action is Taken
Divert Trucks over 16 Ton Gross Vehicle Weight to Sister Bridge
0.9*
18 Months of Temporary Lane Closures on one Bridge; 1 Month of Full Bridge Closure
12 Months of Restrictive Load Postings on One Bridge and Re-routing Trucks over 16 Tons Gross Vehicle Weight to Sister Bridge
0.1*
Same 18 Month Lane Closure; 2 Months of Full Bridge Closure and Load Posting as Above Followed by Additional 18 Months of Temporary & 2 Months of Full Closure on Sister Bridge for Similar Repair Project
****
Unsatisfactory Performance: Catastrophic Damage to Main Truss Member or Critical Gusset Plate
Bridge Permanently Closed
Iniatiate Project for Construction of New Bridge
60 Month Bridge Closure for Design and Construction of a New Bridge

Note:
1. "*" denotes Probability of Occurrence.

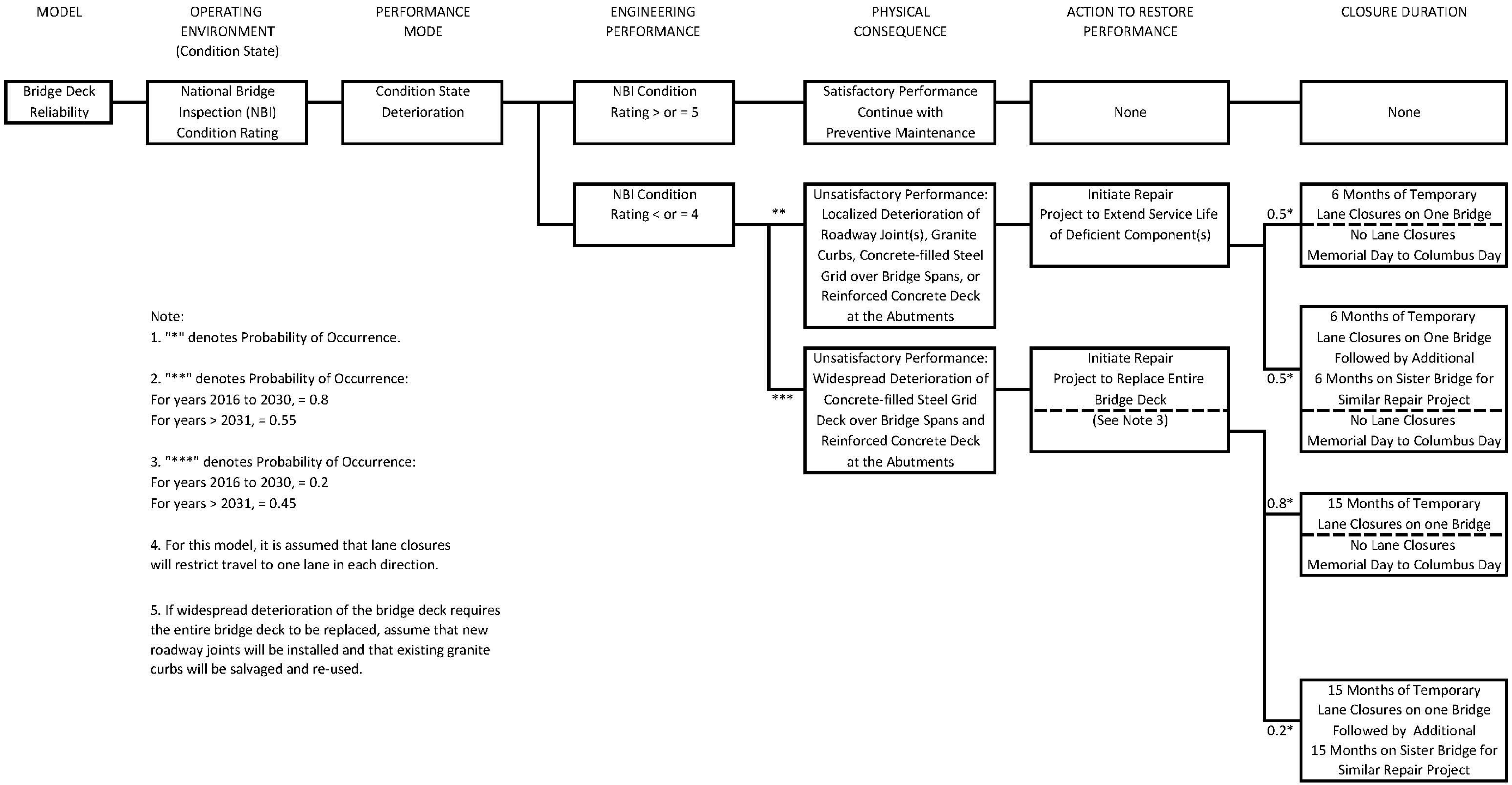
2. "**" denotes Probability of Occurrence:
For years 2016 to 2030, = 0.9
For years > 2031, = 0.7

3. "***" denotes Probability of Occurrence:
For years 2016 to 2030, = 0.0999
For years > 2031, = 0.2999

4. "****" denotes Probability of Occurrence:
For years 2016 to 2065, = 0.0001
For years > 2031, = 0.001

5. For this model, it is assumed that lane closures will restrict travel to one lane in each direction.

FIGURE 8-4: SUPERSTRUCTURE DETERIORATION MODEL-EVENT TREE


MODEL
OPERATING ENVIRONMENT (Condition State)
PERFORMANCE MODE
ENGINEERING PERFORMANCE
PHYSICAL CONSEQUENCE
ACTION TO RESTORE PERFORMANCE
CLOSURE DURATION
Bridge Deck Reliability
National Bridge Inspection (NBI) Condition Rating
Condition State Deterioration
NBI Condition Rating > or = 5
Satisfactory Performance Continue with Preventive Maintenance
None
None
NBI Condition Rating < or = 4
**
Unsatisfactory Performance: Localized Deterioration of Roadway Joint(s), Granite Curbs, Concrete-filled Steel Grid over Bridge Spans, or Reinforced Concrete Deck at the Abutments
Initiate Repair Project to Extend Service Life of Deficient Component(s)
0.5*
6 Months of Temporary Lane Closures on One Bridge
No Lane Closures Memorial Day to Columbus Day
0.5*
6 Months of Temporary Lane Closures on One Bridge Followed by Additional 6 Months on Sister Bridge for Similar Repair Project
No Lane Closures Memorial Day to Columbus Day
***
Unsatisfactory Performance: Widespread Deterioration of Concrete-filled Steel Grid Deck over Bridge Spans and Reinforced Concrete Deck at the Abutments
Initiate Repair Project to Replace Entire Bridge Deck
(See Note 3)
0.8*
15 Months of Temporary Lane Closures on one Bridge
No Lane Closures Memorial Day to Columbus Day
0.2*
15 Months of Temporary Lane Closures on one Bridge Followed by Additional 15 Months on Sister Bridge for Similar Repair Project

Note:

1. "*" denotes Probability of Occurrence.

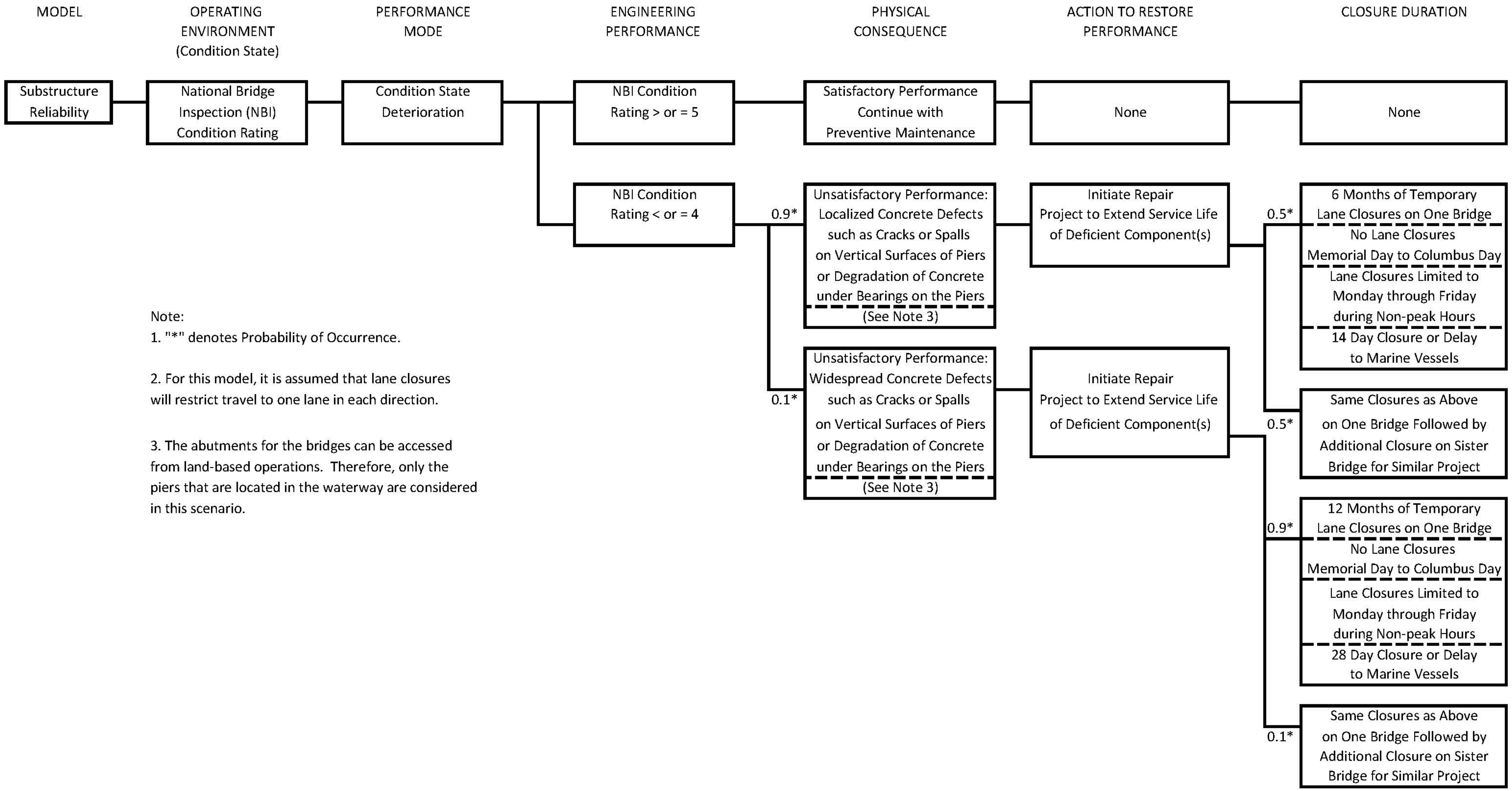
2. "**" denotes Probability of Occurrence:
For years 2016 to 2030, = 0.8
For years > 2031, = 0.55

3. "***" denotes Probability of Occurrence:
For years 2016 to 2030, = 0.2
For years > 2031, = 0.45

4. For this model, it is assumed that lane closures will restrict travel to one lane in each direction.

5. If widespread deterioration of the bridge deck requires the entire bridge deck to be replaced, assume that new roadway joints will be installed and that existing granite curbs will be salvaged and re-used.

FIGURE 8-5: BRIDGE DECK DETERIORATION MODEL-EVENT TREE


MODEL
OPERATING ENVIRONMENT (Condition State)
PERFORMANCE MODE
ENGINEERING PERFORMANCE
PHYSICAL CONSEQUENCE
ACTION TO RESTORE PERFORMANCE
CLOSURE DURATION
Substructure Reliability
National Bridge Inspection (NBI) Condition Rating
Condition State Deterioration
NBI Condition Rating > or = 5
Satisfactory Performance Continue with Preventive Maintenance
None
None
NBI Condition Rating < or = 4
0.9*
Unsatisfactory Performance: Localized Concrete Defects such as Cracks or Spalls on Vertical Surfaces of Piers or Degradation of Concrete under Bearings on the Piers
(See Note 3)
Initiate Repair Project to Extend Service Life of Deficient Component(s)
0.5*
6 Months of Temporary Lane Closures on One Bridge
No Lane Closures Memorial Day to Columbus Day
Lane Closures Limited to Monday through Friday during Non-peak Hours
14 Day Closure or Delay to Marine Vessels
0.5*
Same Closures as Above on One Bridge Followed by Additional Closure on Sister Bridge for Similar Project
0.1*
Unsatisfactory Performance: Widespread Concrete Defects such as Cracks or Spalls on Vertical Surfaces of Piers or Degradation of Concrete under Bearings on the Piers
(See Note 3)
Initiate Repair Project to Extend Service Life of Deficient Component(s)
0.9*
12 Months of Temporary Lane Closures on One Bridge
No Lane Closures Memorial Day to Columbus Day
Lane Closures Limited to Monday through Friday during Non-peak Hours
28 Day Closure or Delay to Marine Vessels
0.1*
Same Closures as Above on One Bridge Followed by Additional Closure on Sister Bridge for Similar Project

Note:

1. "*" denotes Probability of Occurrence.

2. For this model, it is assumed that lane closures will restrict travel to one lane in each direction.

3. The abutments for the bridges can be accessed from land-based operations. Therefore, only the piers that are located in the waterway are considered in this scenario.

FIGURE 8-6: SUBSTRUCTURE DETERIORATION MODEL-EVENT TREE

9. REFERENCES

a. AASHTO LRFD Bridge Design Specification, 5th ed., 2010 (LRFD).

b. AASHTO Manual for Bridge Evaluation, 2nd ed., 2011 (MBE).

c. Estes, A. and Frangopol, D. (2001). "Bridge Lifetime System Reliability under Multiple Limit States." *J. Bridge Eng.*, 10.1061/(ASCE)1084-0702(2001)6:6(523), 523-528.

d. Melik Bolukbasi; Jamshid Mohammadi, M.ASCE; and David Arditi, M.ASCE (2004), “Estimating the Future Condition of Highway Bridge Components Using National Bridge Inventory Data” *Pract. Period. Struct. Des. Constr.*, 2004, 9(1): 16-25.

e. Bridge Preservation Guide, Maintaining State of Good Repair Using Cost Effective Investment Strategies, FHWA Publication Number: FHWA-HIF-11042, August 2011.

f. “Main Truss and Approach Truss Exterior Gusset Plate”, Parsons Brinckerhoff, April 2011

g. “2015 Routine Inspection Report of the Sagamore Bridge Over the Cape Cod Canal”, Transystems, Volumes I & II, February 3, 2016

h. “2017 Routine Inspection Report of the Sagamore Bridge Over the Cape Cod Canal”, Transystems, Volumes I & II, January, 2018

i. “2014 Routine Inspection Report of the Bourne Bridge Over the Cape Cod Canal”, Transystems, Volumes I & II,February 17, 2015

j. “2016 Routine Inspection Report of the Bourne Bridge Over the Cape Cod Canal”, Transystems, Volumes I & II,February 24, 2017

k. Corrosion Measurements, New England District, March 2013

l. “Vertical-Lift Railroad Bridge Major Rehabilitation Evaluation Report”, New England District, May 1997

m. “Atmospheric Corrosion Resistance of Structural Steels”, Albrecht and Hall, ASCE Journal of Material in Civil Engineering, February 2003

n. FHWA-HIF-16-002-VOL. 19, “Corrosion Protection of Steel Bridges”, December 2015

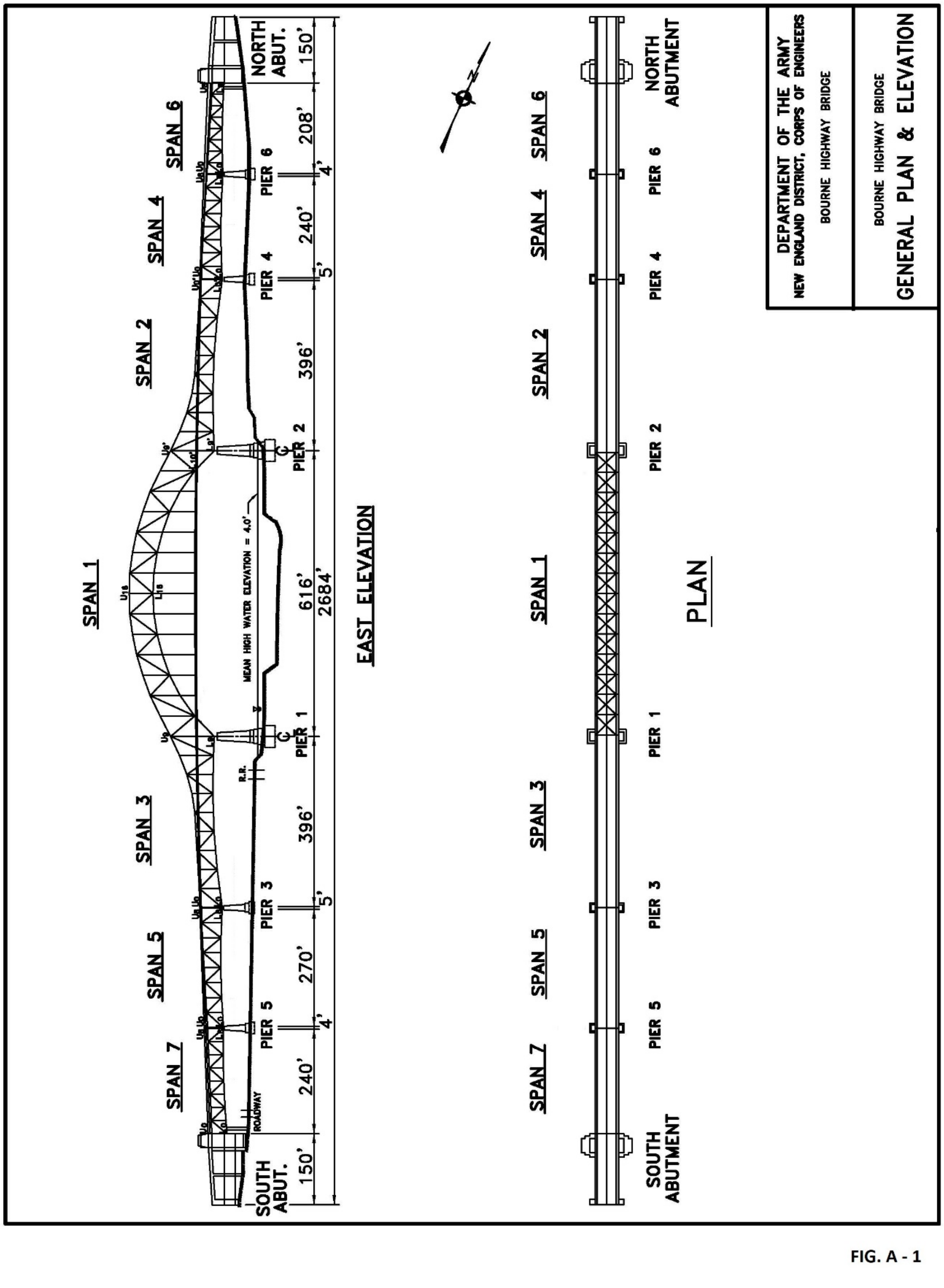
o. “Capacity Loss Due to Corrosion in Steel-Girder Bridges”, Kayser and Nowak, ASCE Journal of Structural Engineering, June 1989

p. ISO. (2012). “Standard 9223 – Corrosion of Metals and Alloys – Corrosivity of Atmospheres – Classification, Determination, and Estimation.” International Standards Organization (ISO). Geneva, Switzerland.

ATTACHMENT A

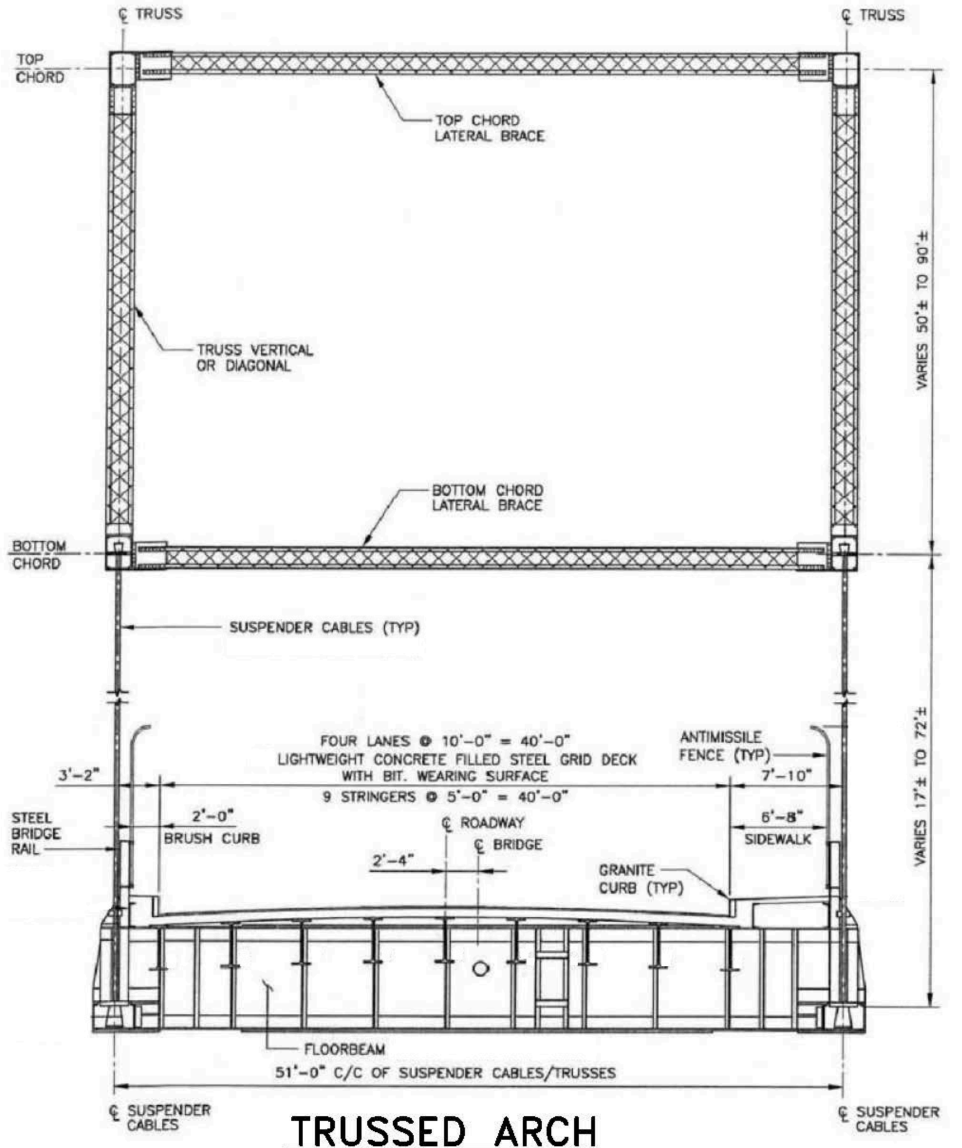
BOURNE & SAGAMORE BRIDGES

DRAWINGS AND PHOTOGRAPHS



DEPARTMENT OF THE ARMY
NEW ENGLAND DISTRICT, CORPS OF ENGINEERS
BOURNE HIGHWAY BRIDGE
BOURNE HIGHWAY BRIDGE
GENERAL PLAN & ELEVATION
EAST ELEVATION
PLAN
SPAN 1
SPAN 2
SPAN 3
SPAN 4
SPAN 5
SPAN 6
SPAN 7
PIER 1
PIER 2
PIER 3
PIER 4
PIER 5
PIER 6
SOUTH ABUT.
NORTH ABUT.
SOUTH ABUTMENT
NORTH ABUTMENT
MEAN HIGH WATER ELEVATION = 4.0'
ROADWAY
R.R.
150'
240'
4'
270'
5'
396'
616'
396'
5'
240'
4'
208'
150'
2684'
U16
L16

FIG. A - 1



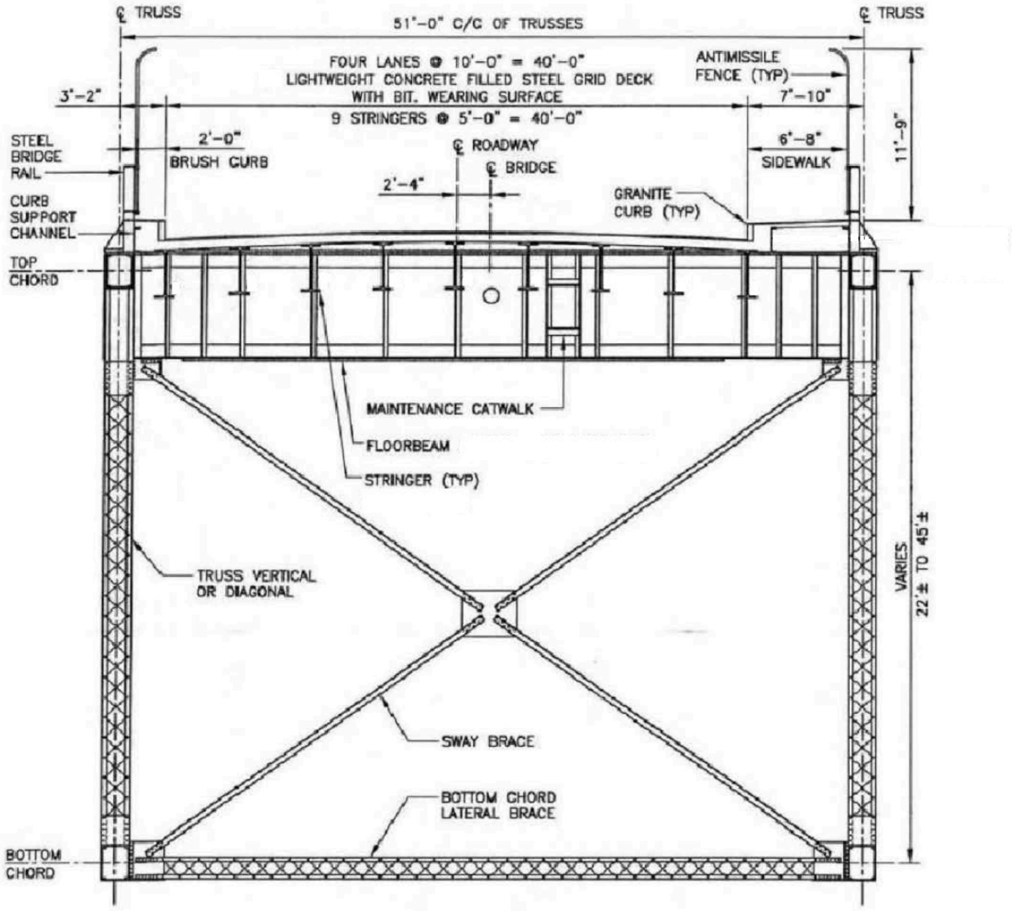
TRUSSED ARCH TYPICAL SECTION (SPAN 1)

(LOOKING SOUTH)

DEPARTMENT OF THE ARMY
NEW ENGLAND DISTRICT, CORPS OF ENGINEERS
BOURNE HIGHWAY BRIDGE

BOURNE HIGHWAY BRIDGE
TRUSSED ARCH
TYPICAL SECTION

FIG. A - 2



DECK TRUSS
TYPICAL SECTION
(SPANS 2 & 3)

(LOOKING SOUTH)

DEPARTMENT OF THE ARMY
NEW ENGLAND DISTRICT, CORPS OF ENGINEERS
BOURNE HIGHWAY BRIDGE

BOURNE HIGHWAY BRIDGE
DECK TRUSS
TYPICAL SECTION

FIG. A - 3

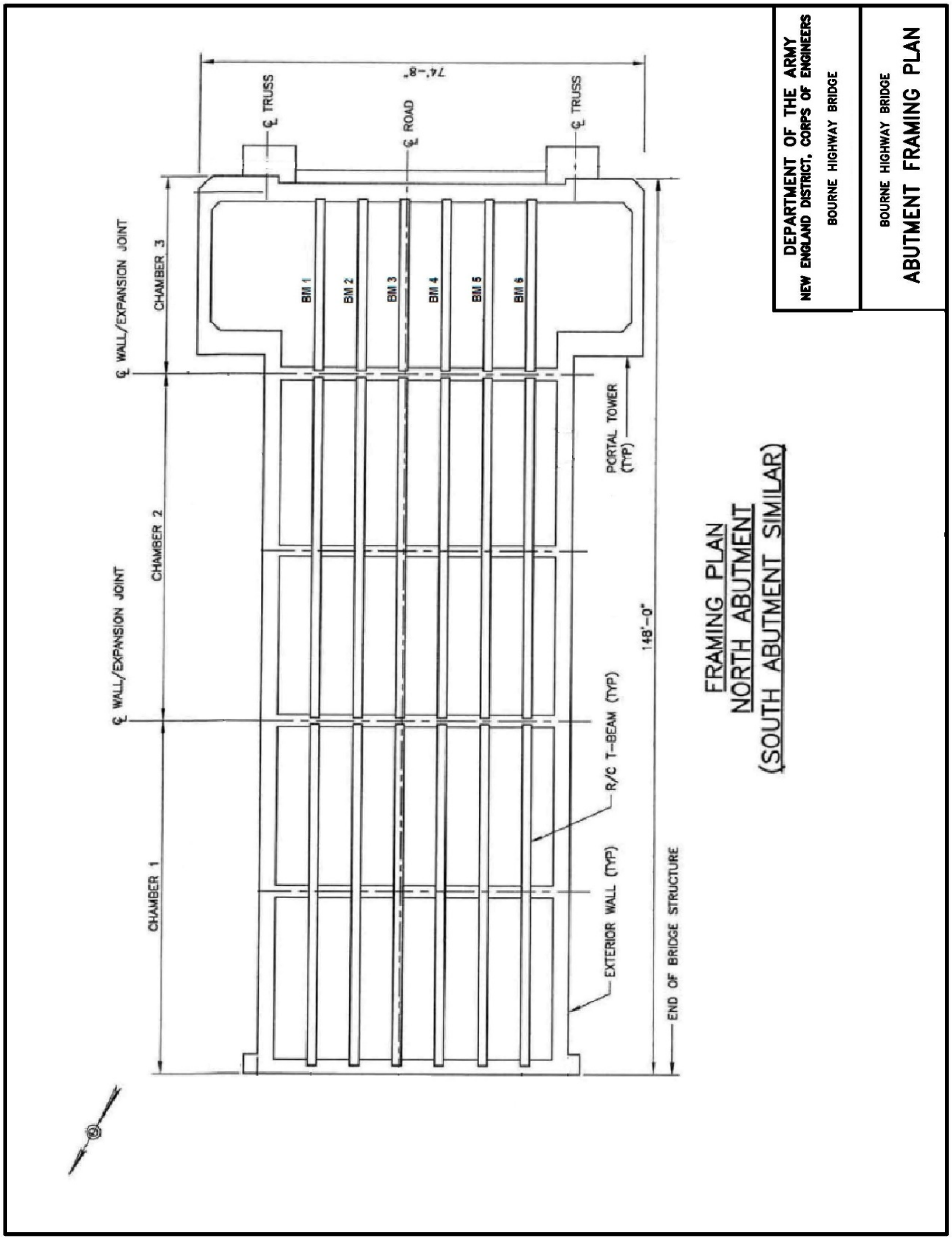

℄ TRUSS
74'-8"
℄ ROAD
℄ TRUSS
℄ WALL/EXPANSION JOINT
CHAMBER 3
BM 1
BM 2
BM 3
BM 4
BM 5
BM 6
PORTAL TOWER (TYP)
CHAMBER 2
℄ WALL/EXPANSION JOINT
148'-0"
R/C T-BEAM (TYP)
CHAMBER 1
EXTERIOR WALL (TYP)
END OF BRIDGE STRUCTURE
FRAMING PLAN
NORTH ABUTMENT
(SOUTH ABUTMENT SIMILAR)
DEPARTMENT OF THE ARMY
NEW ENGLAND DISTRICT, CORPS OF ENGINEERS
BOURNE HIGHWAY BRIDGE
BOURNE HIGHWAY BRIDGE
ABUTMENT FRAMING PLAN

FIG. A - 4

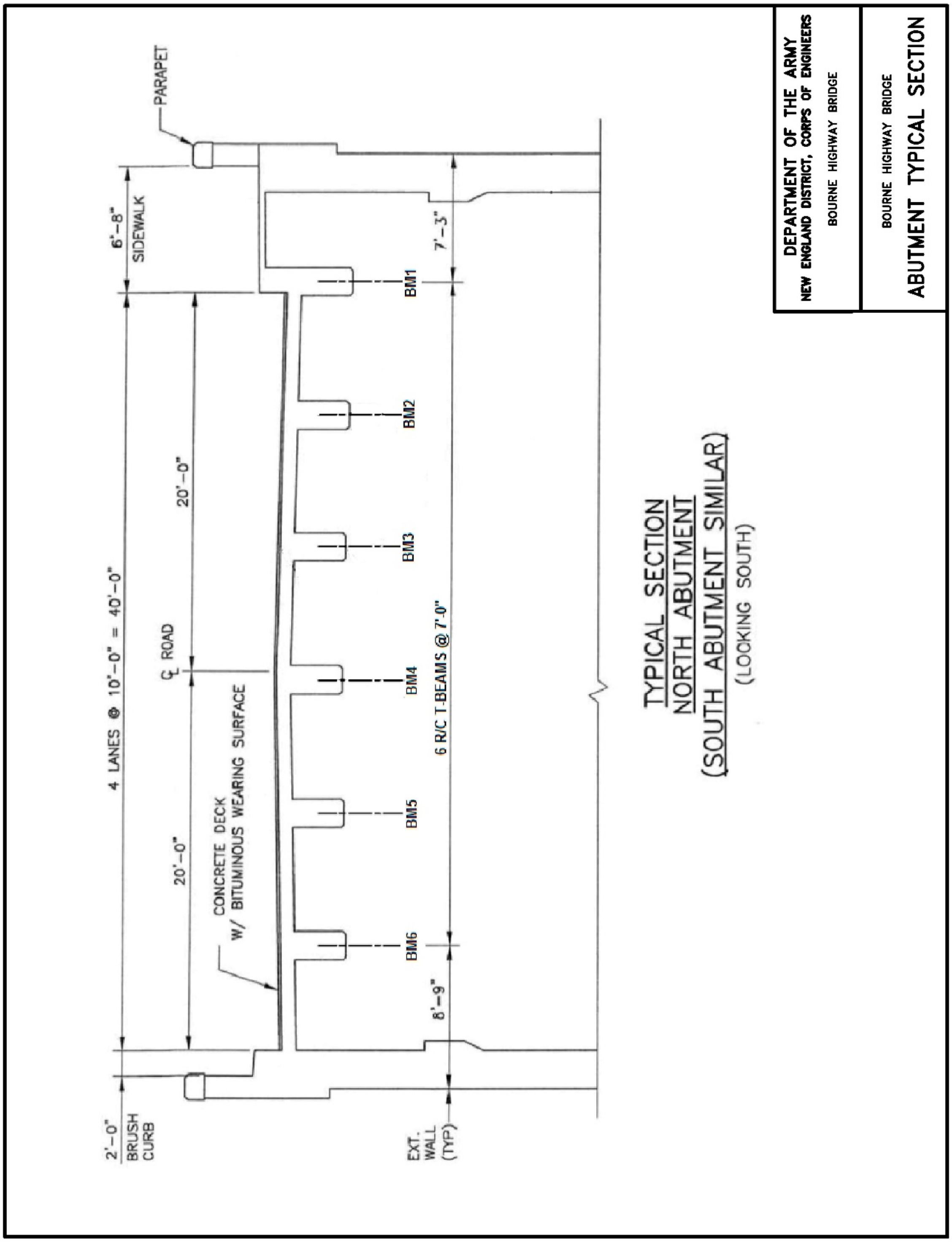

PARAPET
6'-8"
SIDEWALK
7'-3"
4 LANES @ 10'-0" = 40'-0"
20'-0"
20'-0"
℄ ROAD
CONCRETE DECK
W/ BITUMINOUS WEARING SURFACE
BM1
BM2
BM3
BM4
BM5
BM6
6 R/C T-BEAMS @ 7'-0"
8'-9"
2'-0"
BRUSH
CURB
EXT.
WALL
(TYP)
TYPICAL SECTION
NORTH ABUTMENT
(SOUTH ABUTMENT SIMILAR)
(LOCKING SOUTH)
DEPARTMENT OF THE ARMY
NEW ENGLAND DISTRICT, CORPS OF ENGINEERS
BOURNE HIGHWAY BRIDGE
BOURNE HIGHWAY BRIDGE
ABUTMENT TYPICAL SECTION

FIG. A - 5

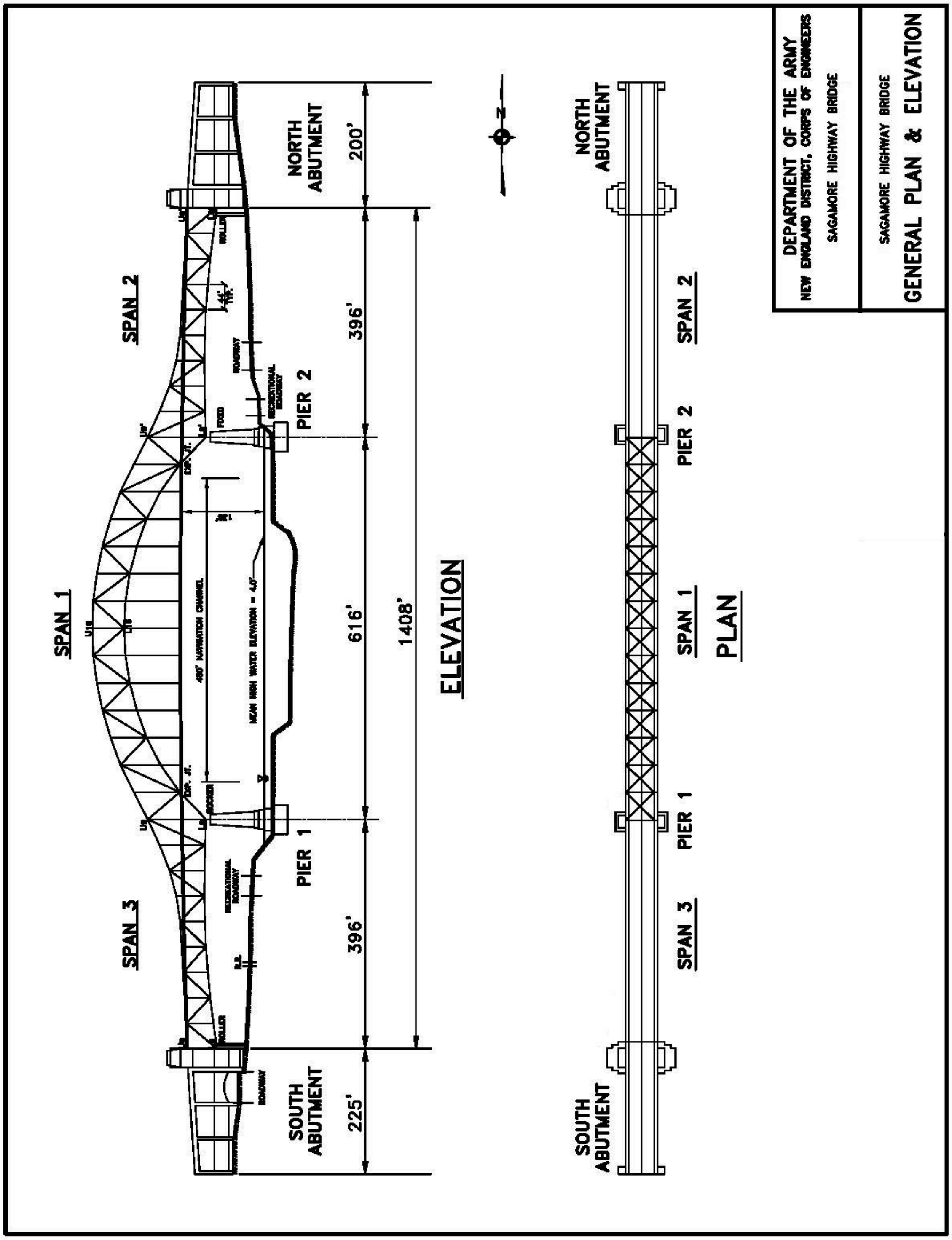
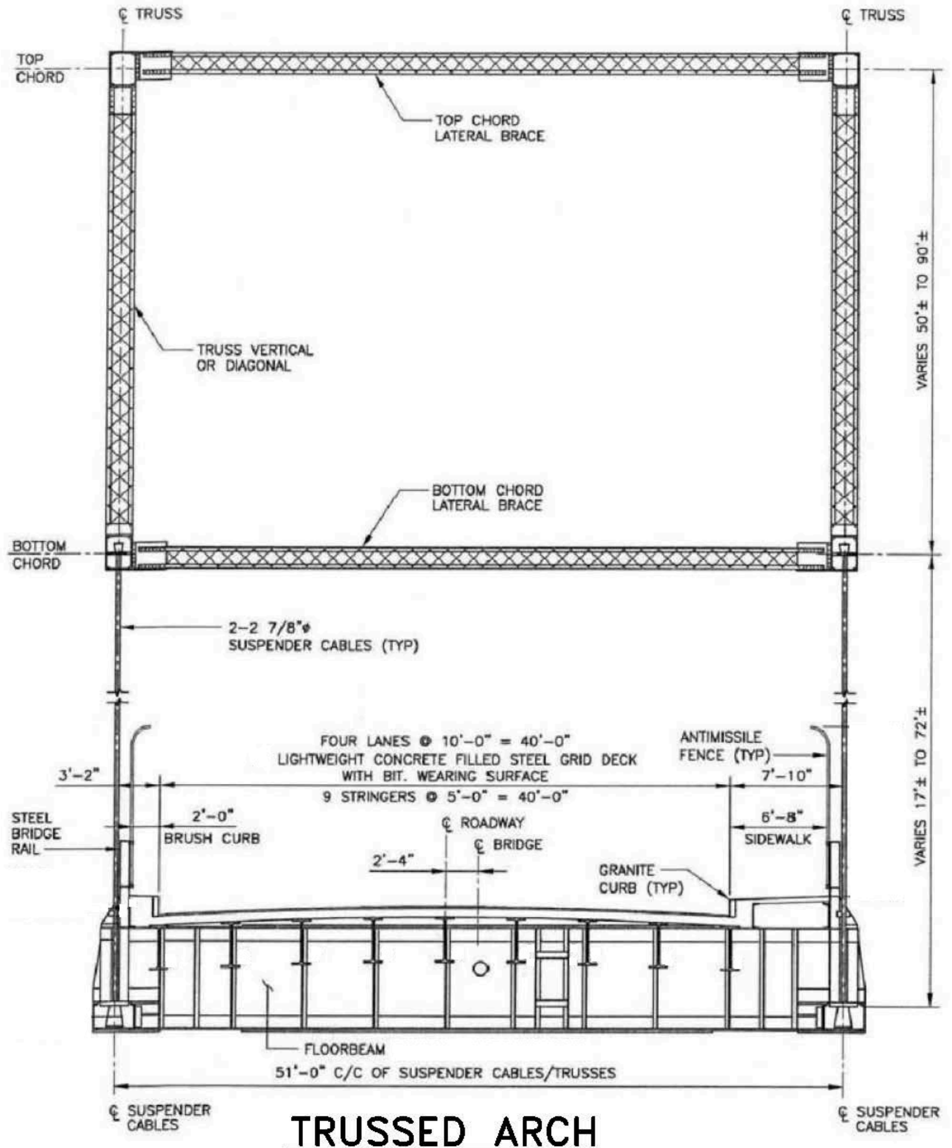

DEPARTMENT OF THE ARMY
NEW ENGLAND DISTRICT, CORPS OF ENGINEERS
SAGAMORE HIGHWAY BRIDGE
SAGAMORE HIGHWAY BRIDGE
GENERAL PLAN & ELEVATION
ELEVATION
PLAN
SPAN 1
SPAN 2
SPAN 3
PIER 1
PIER 2
NORTH ABUTMENT
SOUTH ABUTMENT
200'
396'
616'
396'
225'
1408'
N
U16
L16
U8
L8
U8'
L8'
U0
L0
EXP. JT.
EXP. JT.
ROCKER
FIXED
ROLLER
ROLLER
ROADWAY
ROADWAY
RECREATIONAL ROADWAY
RECREATIONAL ROADWAY
R.R.
480' NAVIGATION CHANNEL
MEAN HIGH WATER ELEVATION = 4.0'
135'
1.44'
TYP.

FIG. A - 6



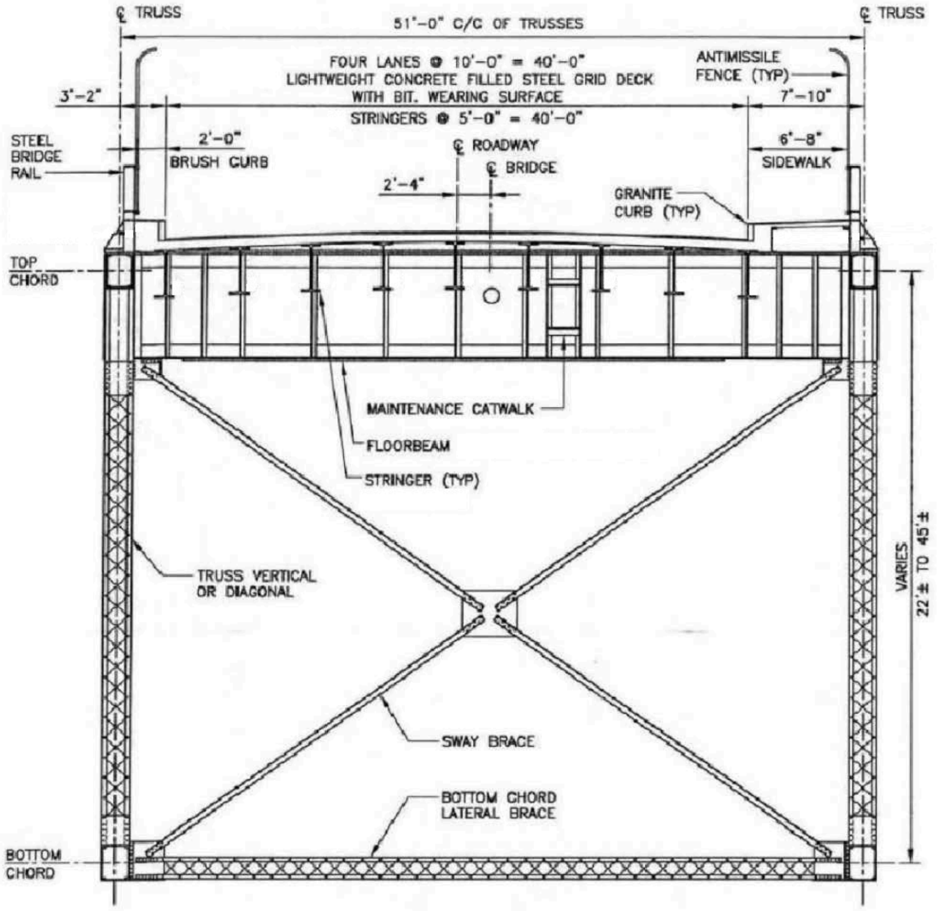
TRUSSED ARCH TYPICAL SECTION (SPAN 1)

(LOOKING NORTH)

DEPARTMENT OF THE ARMY
NEW ENGLAND DISTRICT, CORPS OF ENGINEERS
SAGAMORE HIGHWAY BRIDGE

SAGAMORE HIGHWAY BRIDGE
TRUSSED ARCH
TYPICAL SECTION

FIG. A - 7



DECK TRUSS
TYPICAL SECTION
(SPANS 2 & 3)
(LOOKING NORTH)

DEPARTMENT OF THE ARMY
NEW ENGLAND DISTRICT, CORPS OF ENGINEERS
SAGAMORE HIGHWAY BRIDGE

SAGAMORE HIGHWAY BRIDGE
DECK TRUSS
TYPICAL SECTION

FIG. A - 8

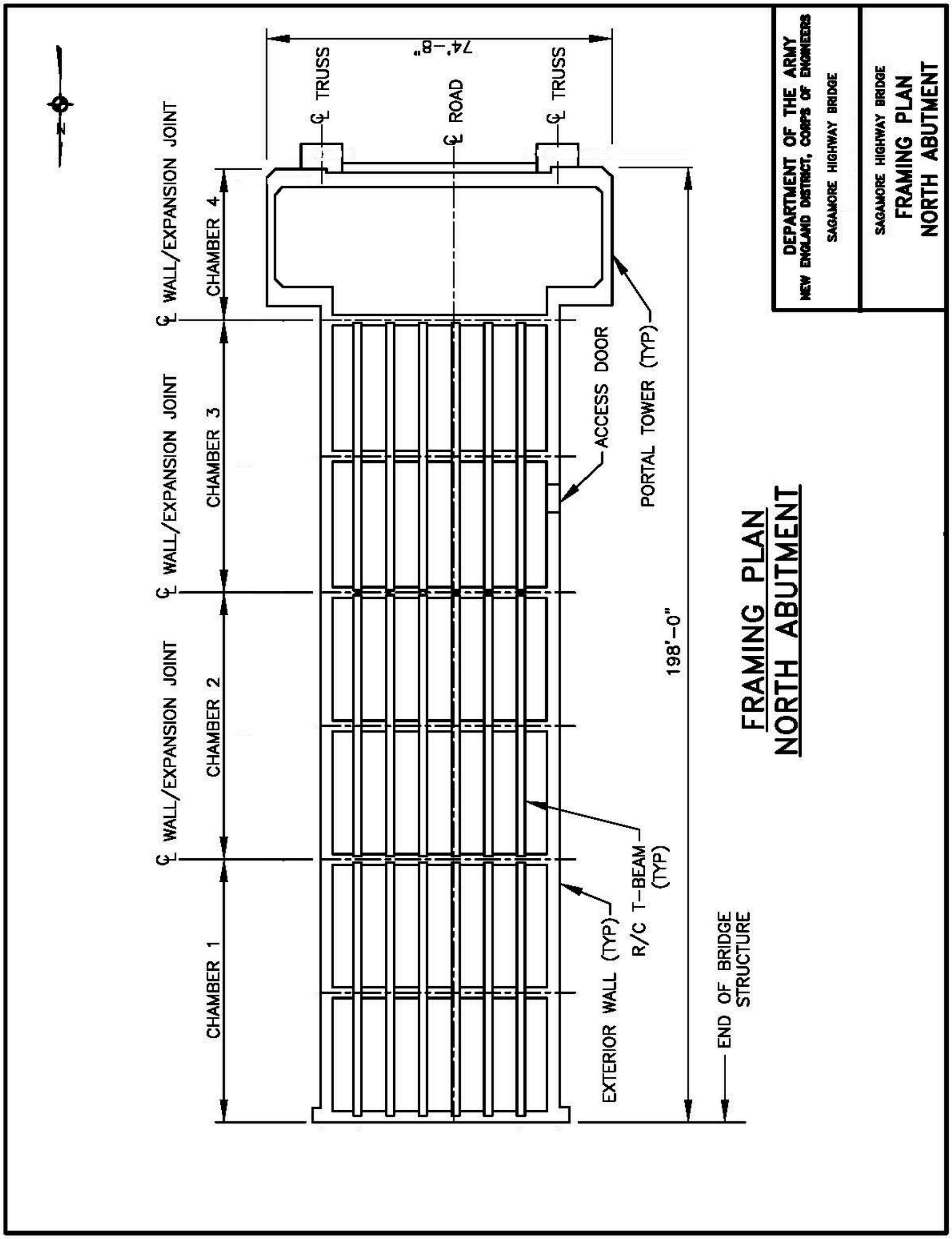

DEPARTMENT OF THE ARMY
NEW ENGLAND DISTRICT, CORPS OF ENGINEERS
SAGAMORE HIGHWAY BRIDGE
SAGAMORE HIGHWAY BRIDGE
FRAMING PLAN
NORTH ABUTMENT
FRAMING PLAN
NORTH ABUTMENT
N
74'-8"
℄ TRUSS
℄ ROAD
℄ TRUSS
℄ WALL/EXPANSION JOINT
CHAMBER 4
℄ WALL/EXPANSION JOINT
CHAMBER 3
℄ WALL/EXPANSION JOINT
CHAMBER 2
℄ WALL/EXPANSION JOINT
CHAMBER 1
ACCESS DOOR
PORTAL TOWER (TYP)
198'-0"
R/C T-BEAM (TYP)
EXTERIOR WALL (TYP)
END OF BRIDGE STRUCTURE

FIG. A - 9

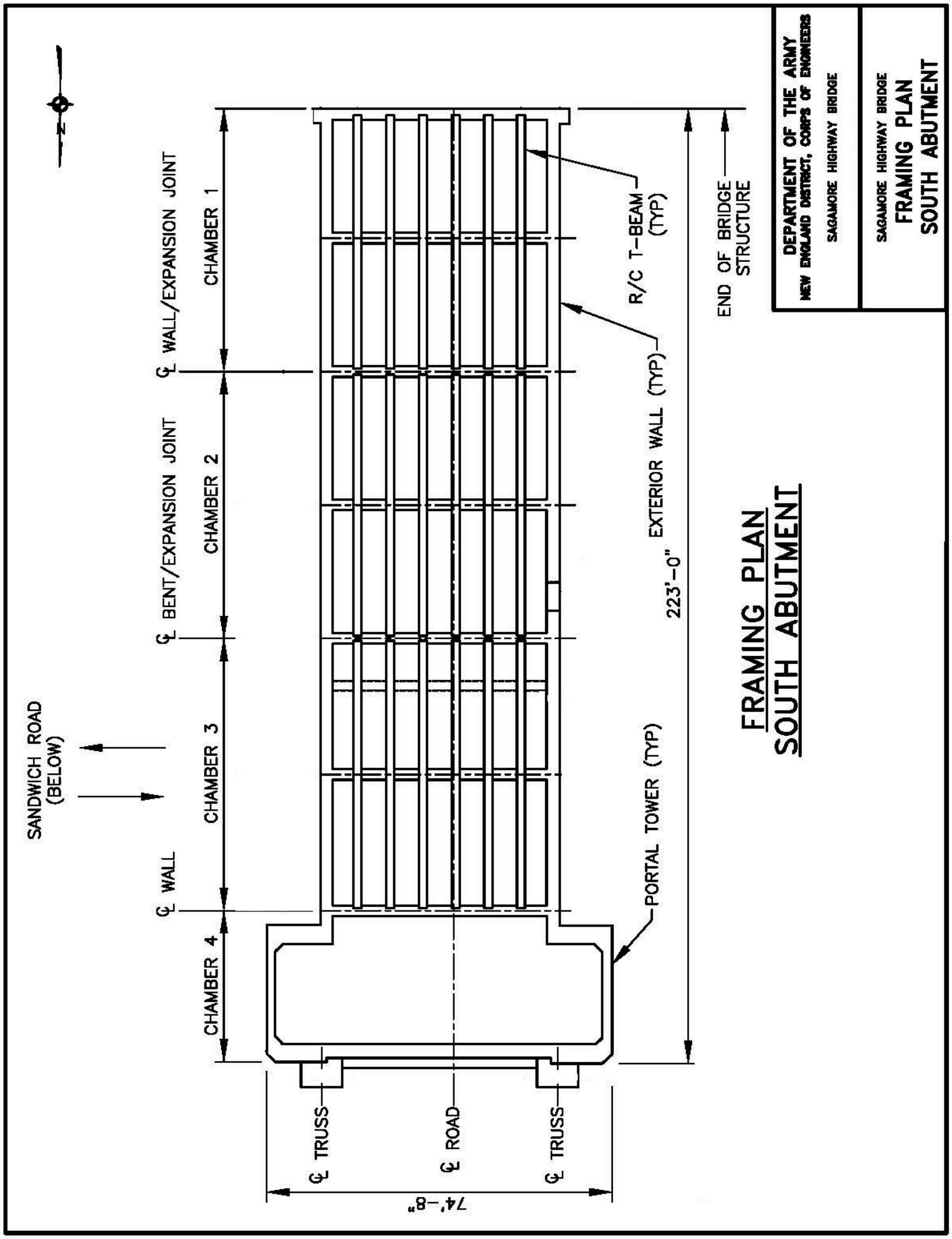
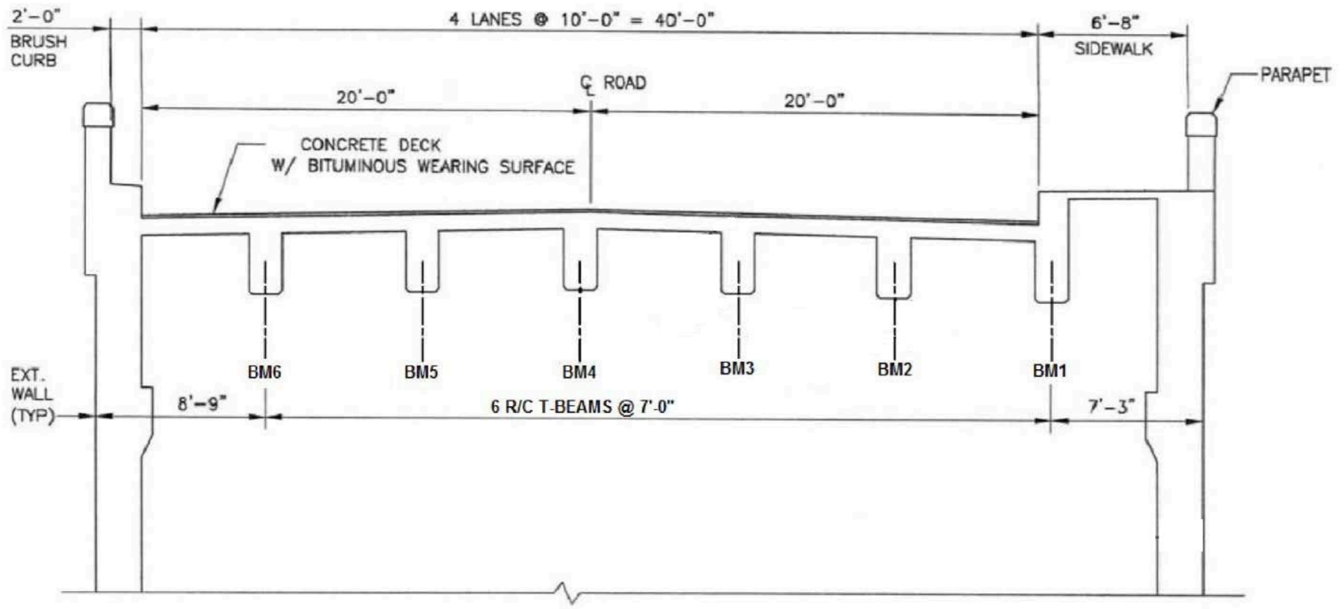

SANDWICH ROAD (BELOW)
N
℄ WALL/EXPANSION JOINT
℄ BENT/EXPANSION JOINT
℄ WALL
CHAMBER 1
CHAMBER 2
CHAMBER 3
CHAMBER 4
R/C T-BEAM (TYP)
EXTERIOR WALL (TYP)
PORTAL TOWER (TYP)
END OF BRIDGE STRUCTURE
223'-0"
℄ TRUSS
℄ ROAD
℄ TRUSS
74'-8"
FRAMING PLAN
SOUTH ABUTMENT
DEPARTMENT OF THE ARMY
NEW ENGLAND DISTRICT, CORPS OF ENGINEERS
SAGAMORE HIGHWAY BRIDGE
SAGAMORE HIGHWAY BRIDGE
FRAMING PLAN
SOUTH ABUTMENT

FIG. A - 10



TYPICAL SECTION
NORTH ABUTMENT
(SOUTH ABUTMENT SIMILAR)
(LOOKING NORTH)

DEPARTMENT OF THE ARMY
NEW ENGLAND DISTRICT, CORPS OF ENGINEERS
SAGAMORE HIGHWAY BRIDGE

SAGAMORE HIGHWAY BRIDGE
ABUTMENT TYPICAL SECTION

FIG. A - 11

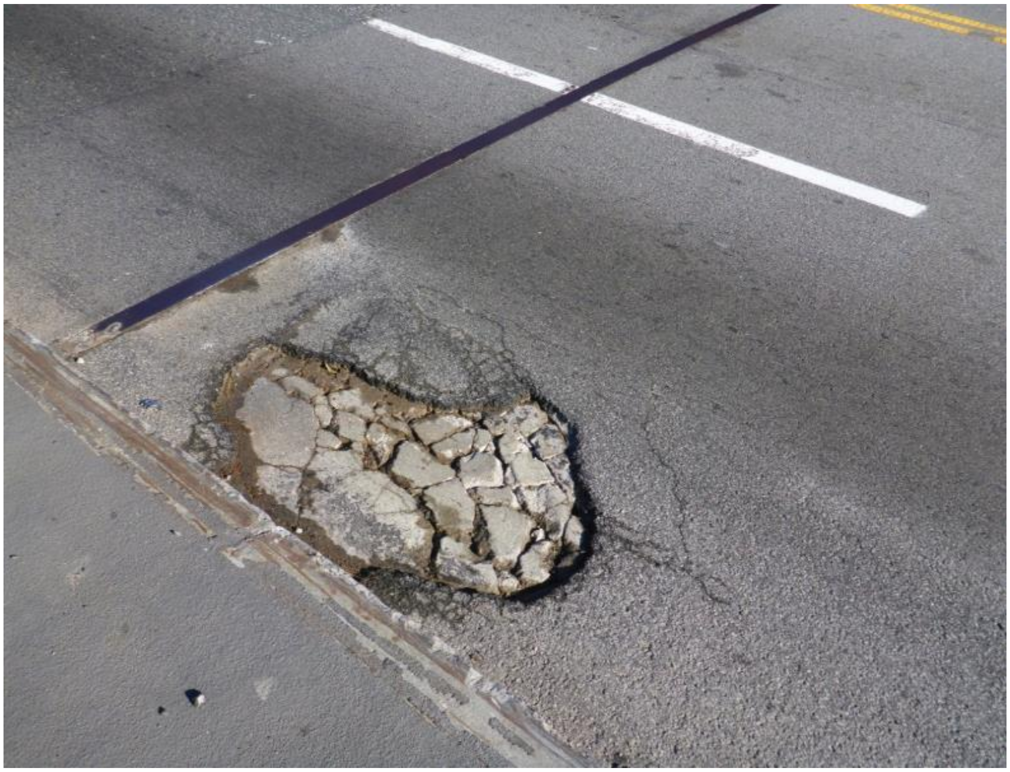


Photo 1 – Bourne Bridge, deteriorated deck of north abutment.

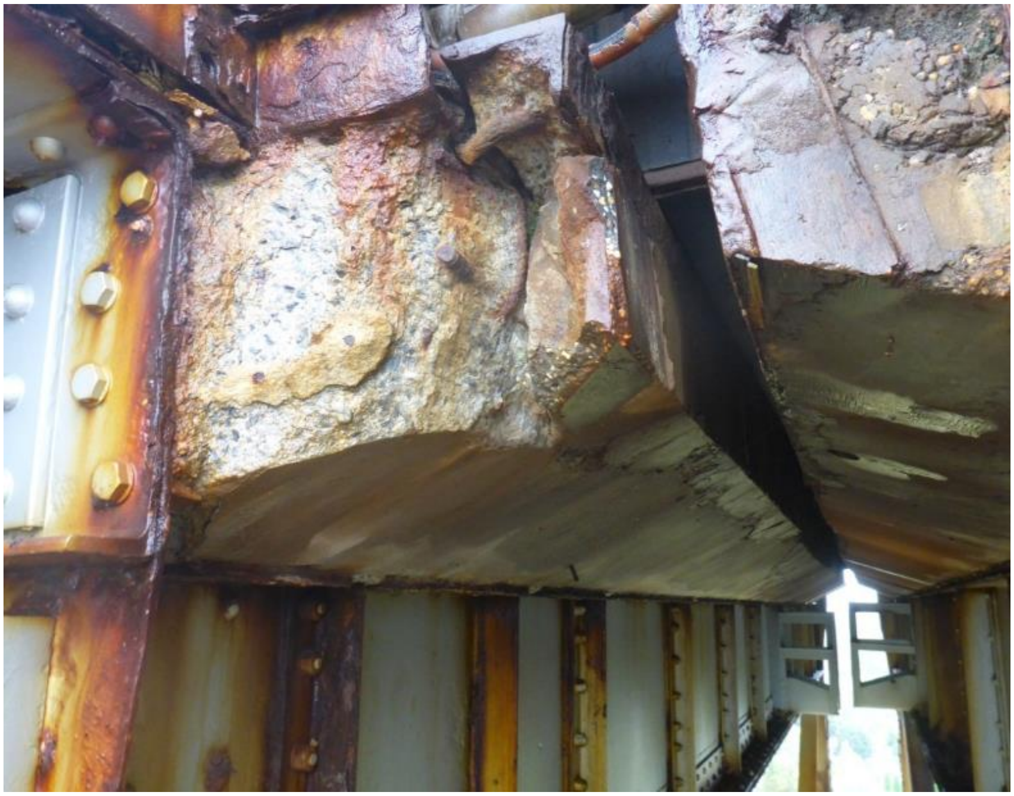


Photo 2 – Bourne Bridge, underside of Pier 3 deck joint.

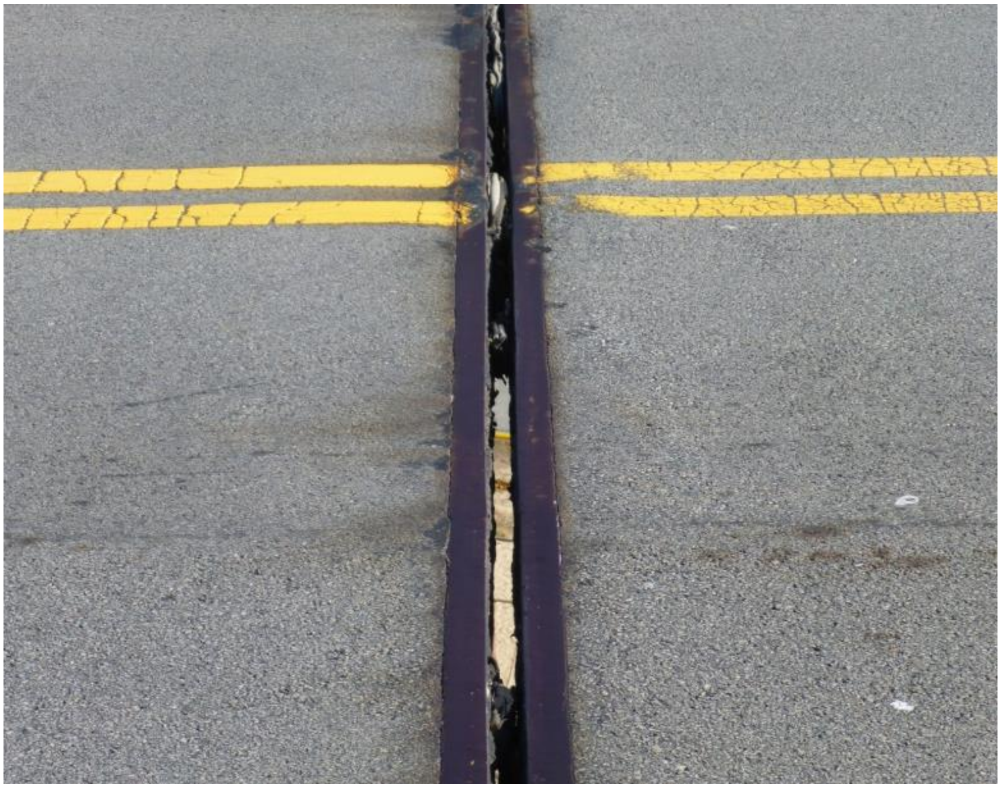


Photo 3 – Bourne Bridge, dislodged and missing compression seal @ Pier 6 deck joint.

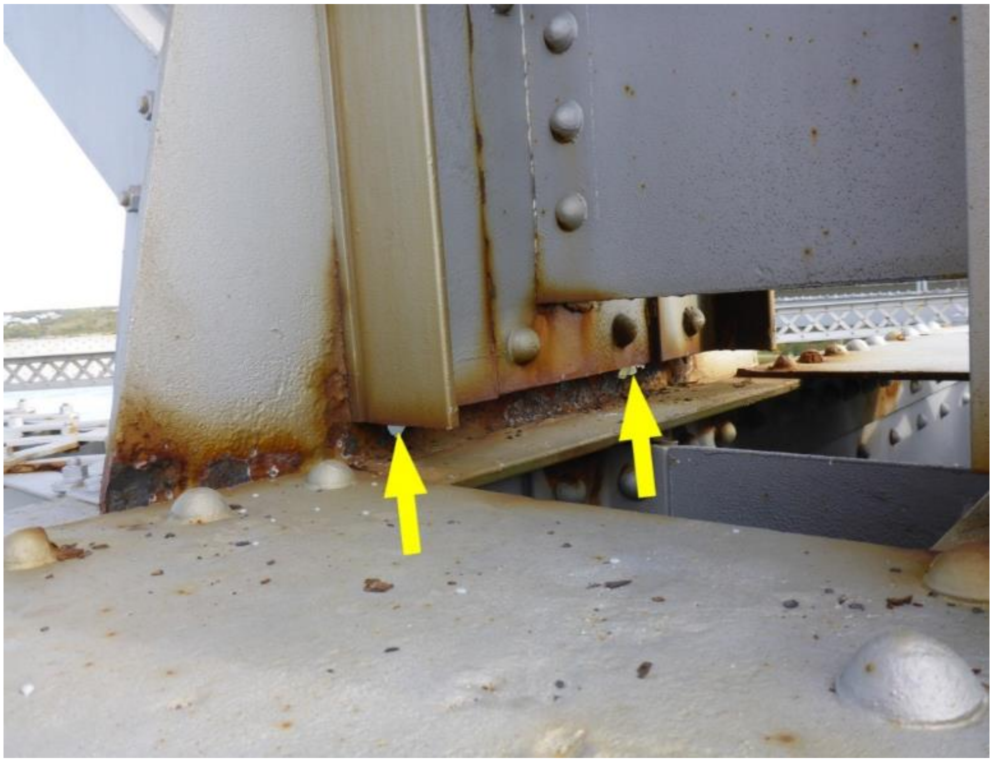


Photo 4 – Bourne Bridge, Span 2, west truss, east gusset plate at L7' with holes along the top of the lower chord member.

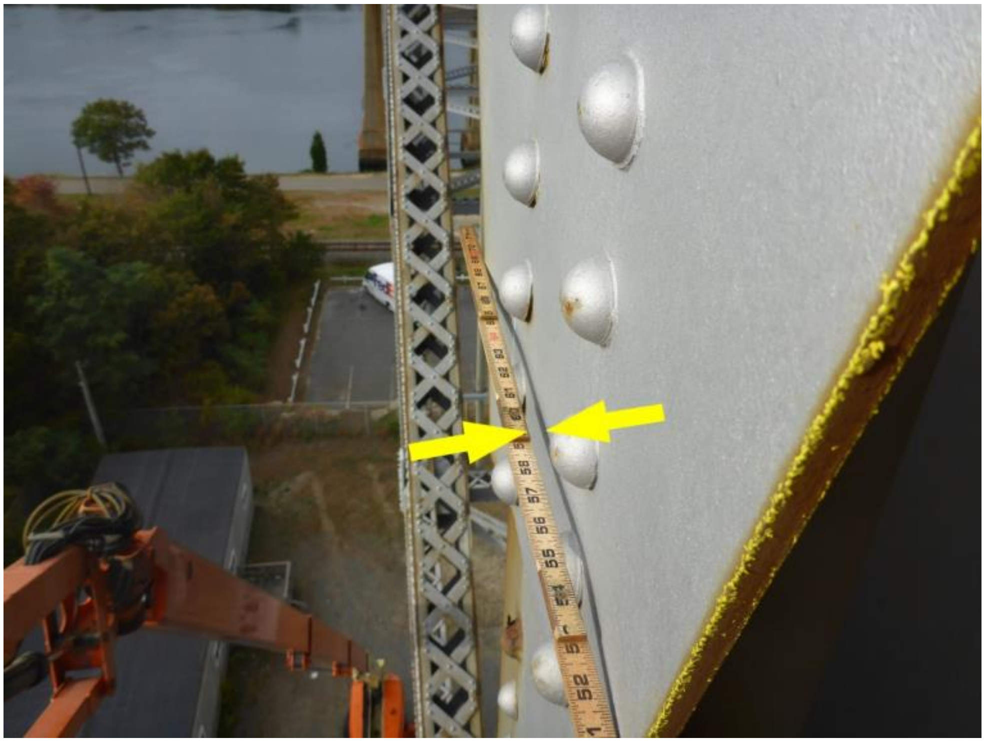


Photo 5 – Bourne Bridge, Span 3, west truss, west gusset plate at U0 with thick pack rust along both edges deforming the gusset plate.

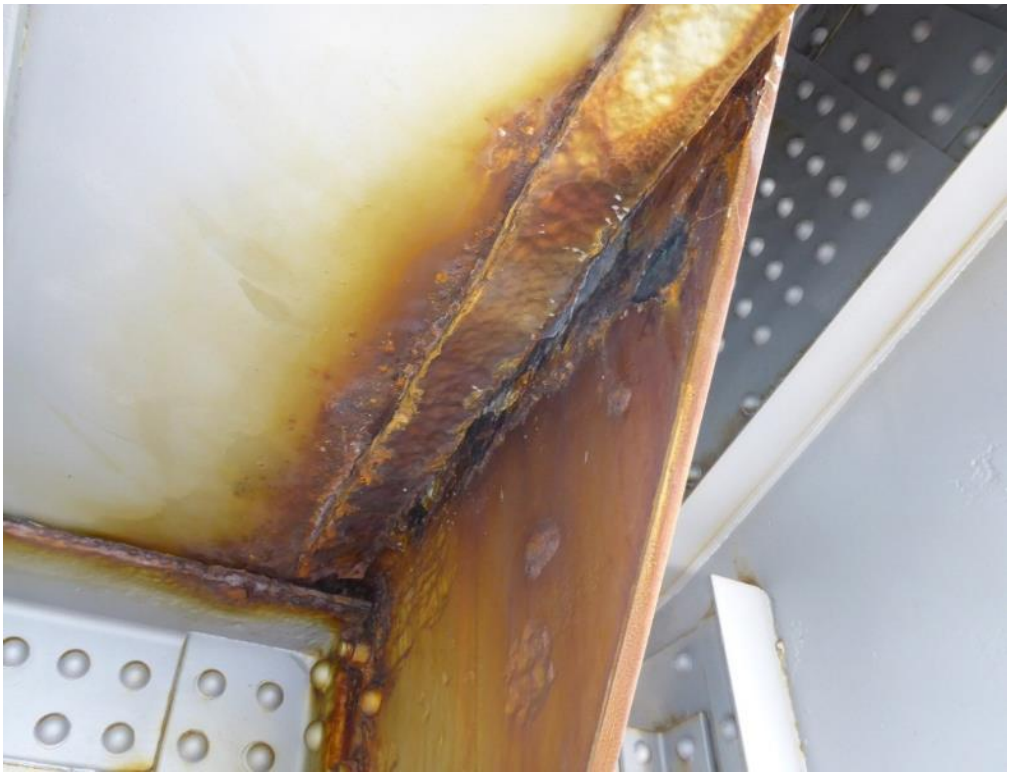


Photo 6 – Bourne Bridge, Span 2, east truss, west gusset plate at U6': section loss with active corrosion along the interface with the sidewalk curb channel.

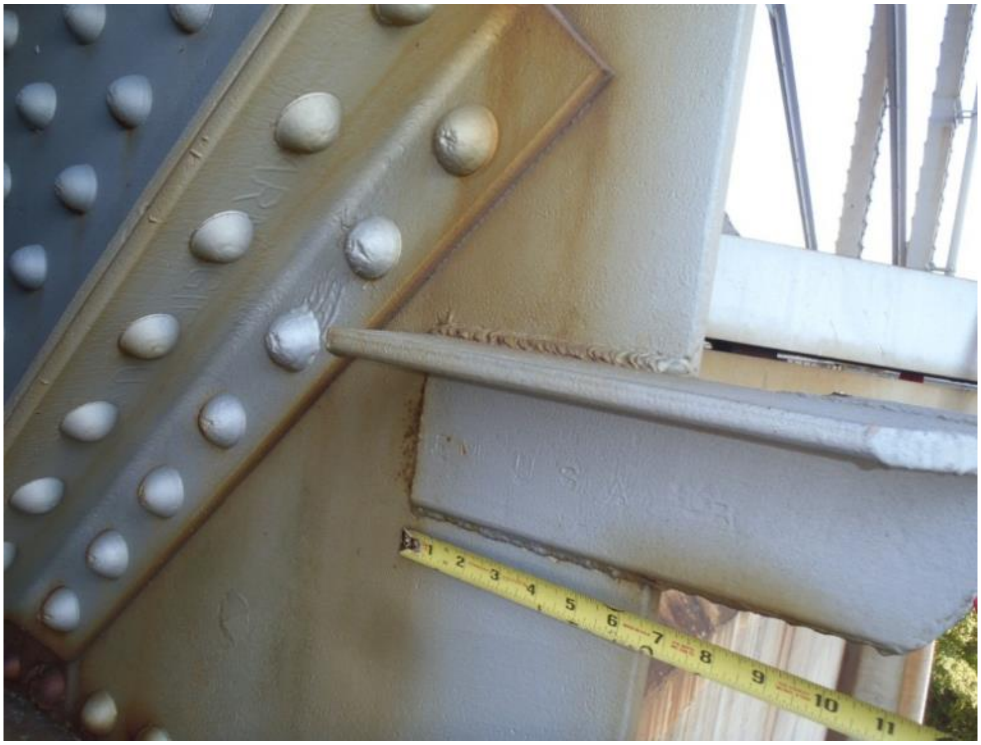


Photo 7 – Bourne Bridge, Span 4, west truss joint L8: Angle welded to the interior face of the east gusset plate (considered a FSD).

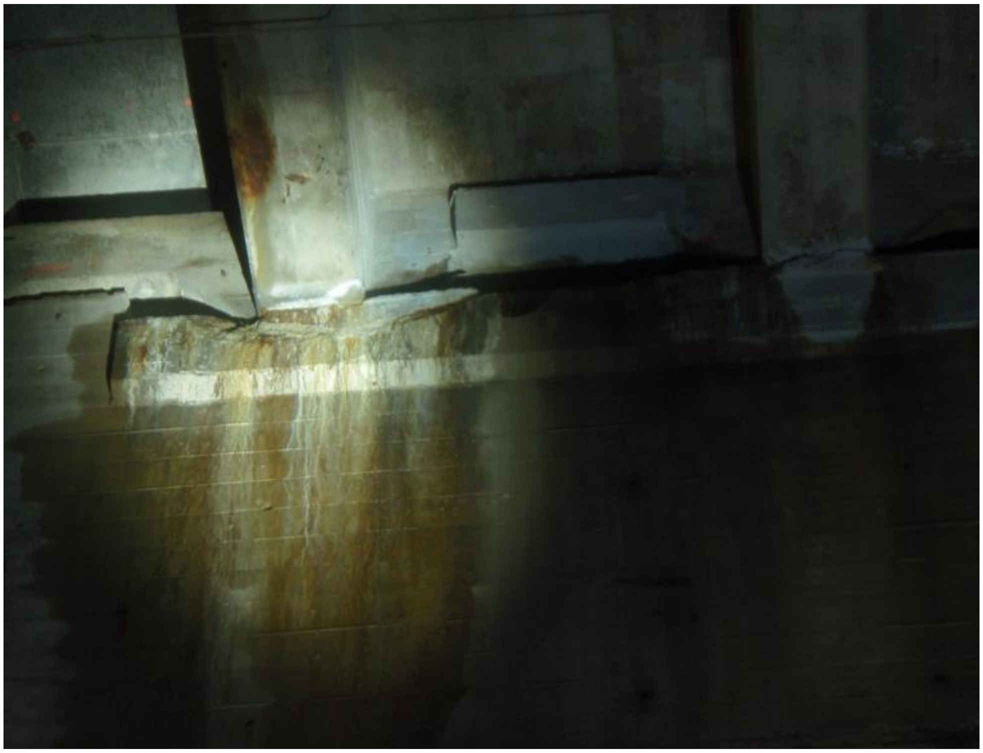


Photo 8 – Bourne Bridge, Beam BM1, chamber 2 of the south abutment: The bearing area is undermined resulting in a 33% reduction in bearing area.

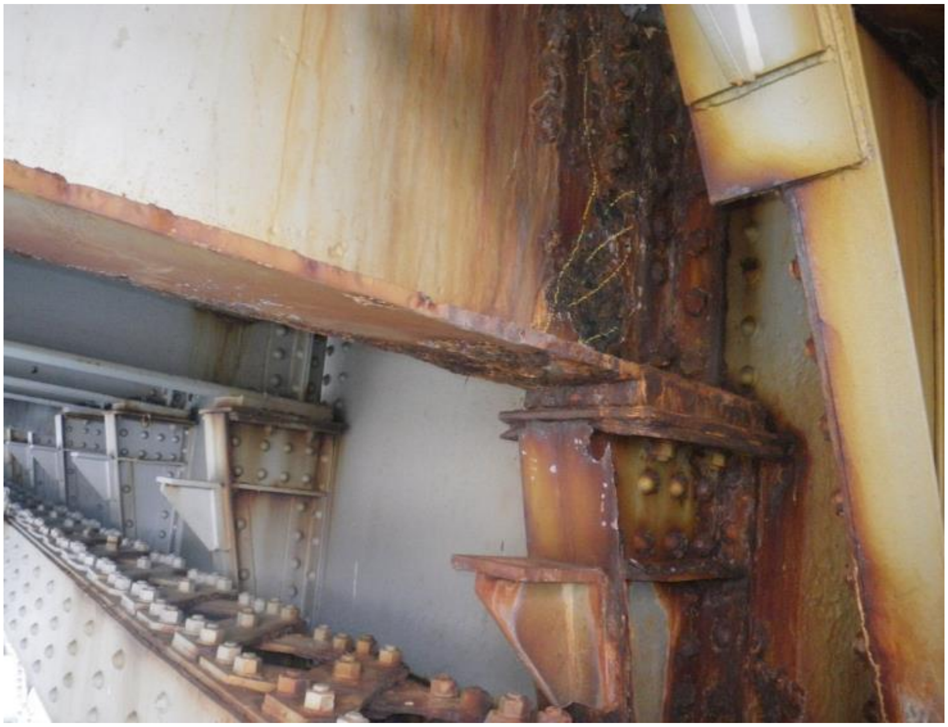


Photo 9 – Bourne Bridge, Span 1, north side of floorbeam FB10: Active corrosion with 1/16" loss by full height of the web.

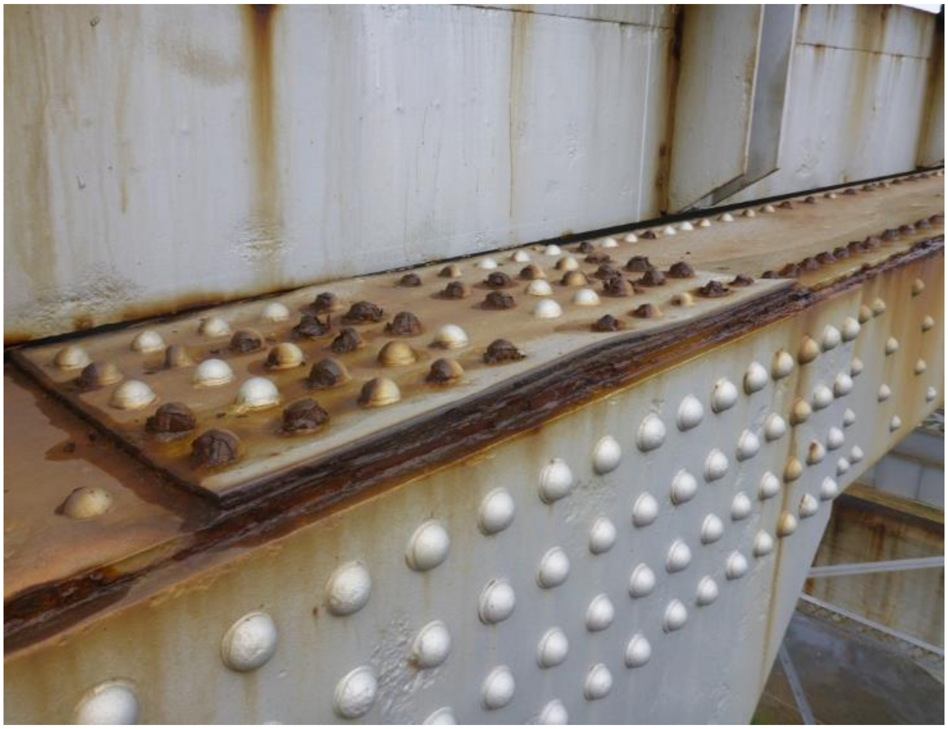


Photo 10 – Bourne Bridge, Span 5, east truss upper chord member U5U6 has up to 1" thick pack rust at the top splice plate with active corrosion on the rivet heads.

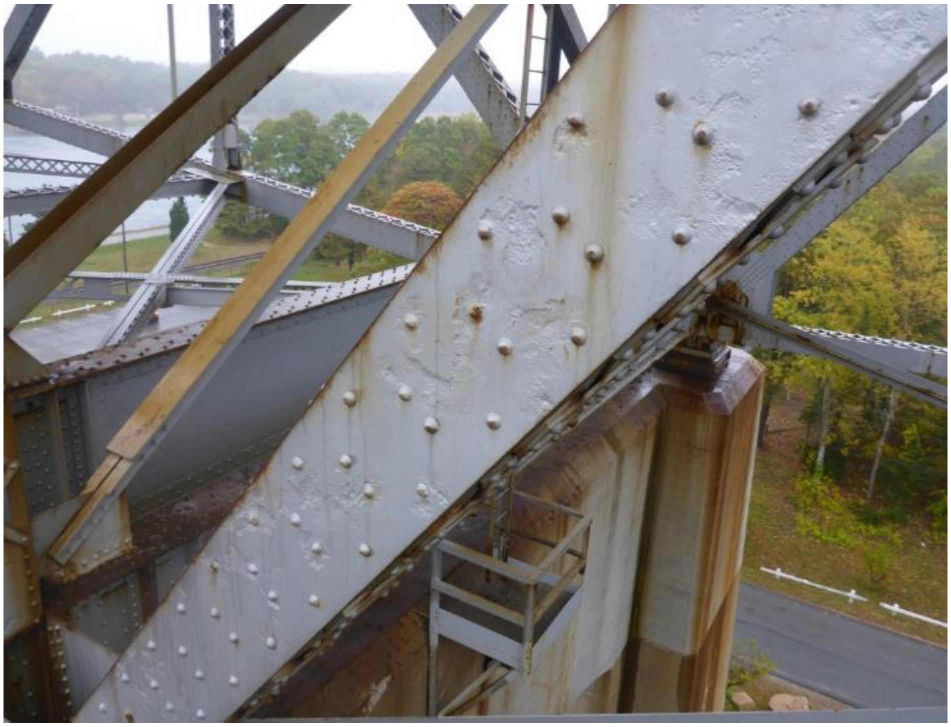


Photo 11 – Bourne Bridge, Span 5, west truss diagonal L8U7: Widespread 1/16" deep pitting.

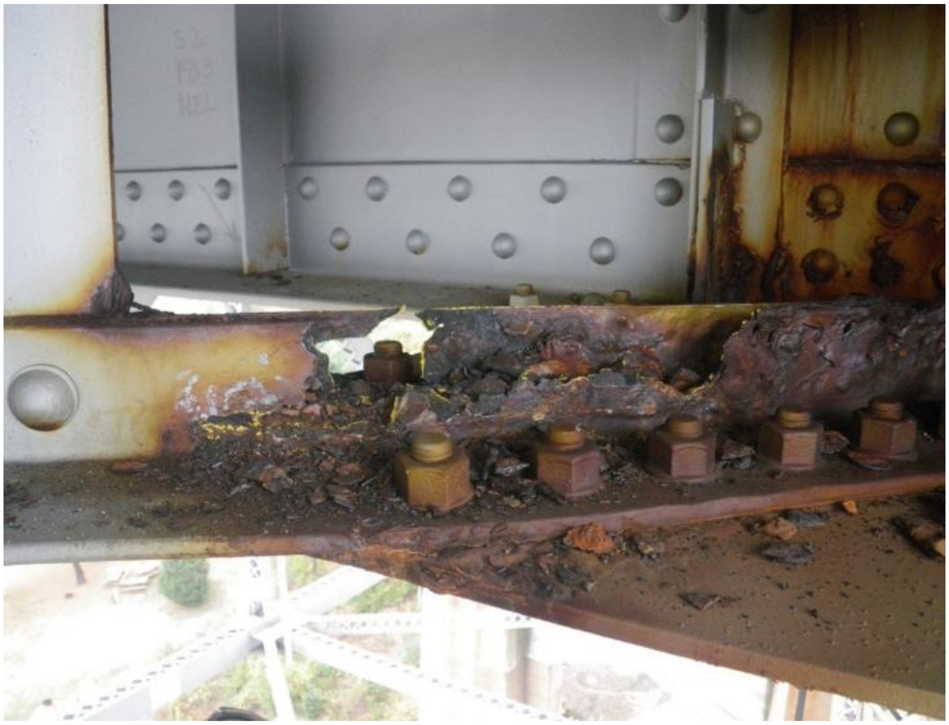


Photo 12 – Bourne Bridge, Span 2, upper lateral bracing at the connection to the east truss at U3': 100% loss by full height of both vertical legs of the bottom flange angles.

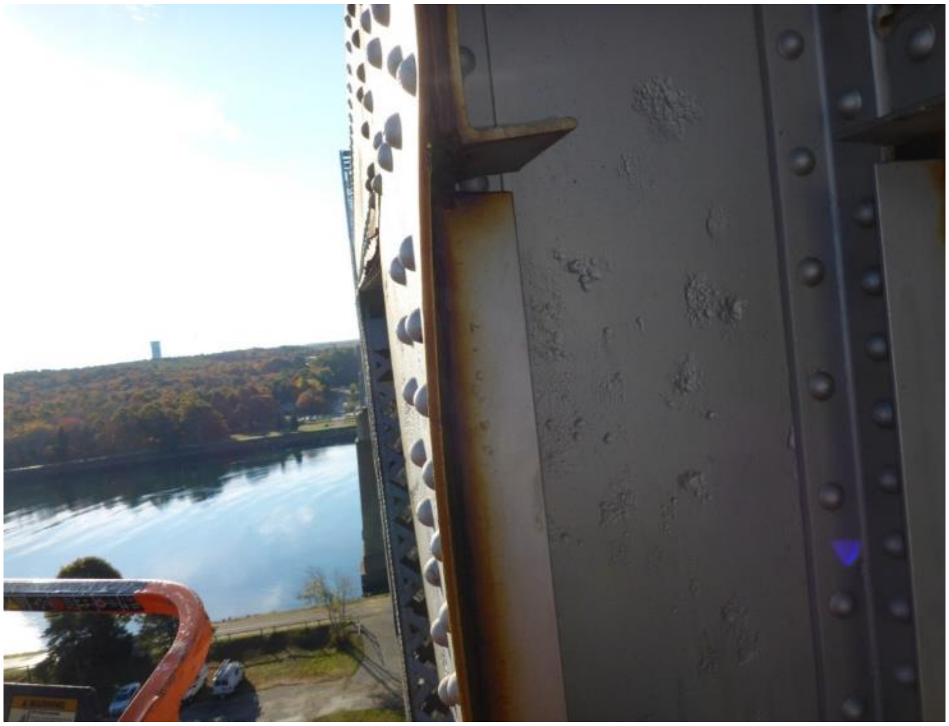


Photo 13 – Bourne Bridge, Span 2, east truss, east gusset plate at U0': 1/2" thick pack rust along both edges of the truss vertical member with deforming of the gusset plate.

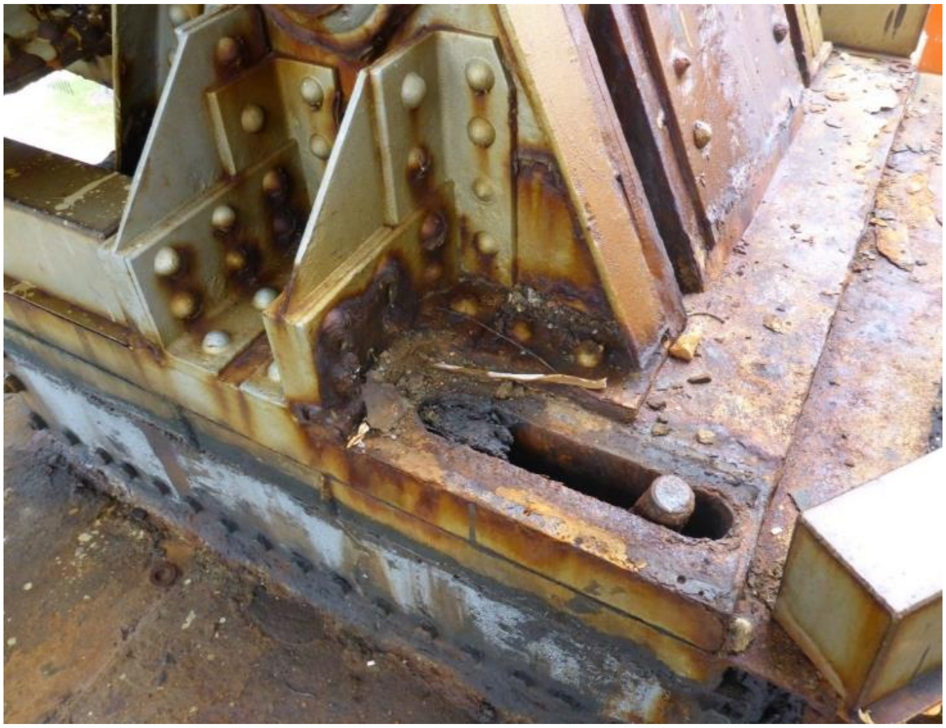


Photo 14 – Bourne Bridge, Span 3, east bearing at pier 3 has a detached covering and a broken anchor bolt.

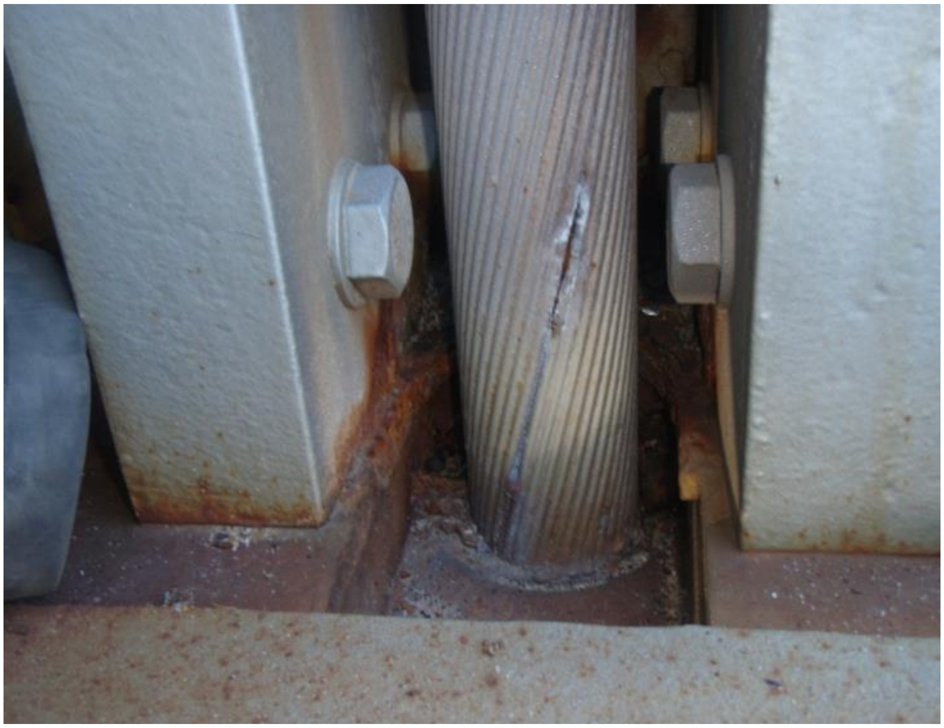


Photo 15 – Bourne Bridge, south suspender at east truss joint 14': A 1/16" wide gap by 6" long between two wires, indicative of stage IV corrosion.

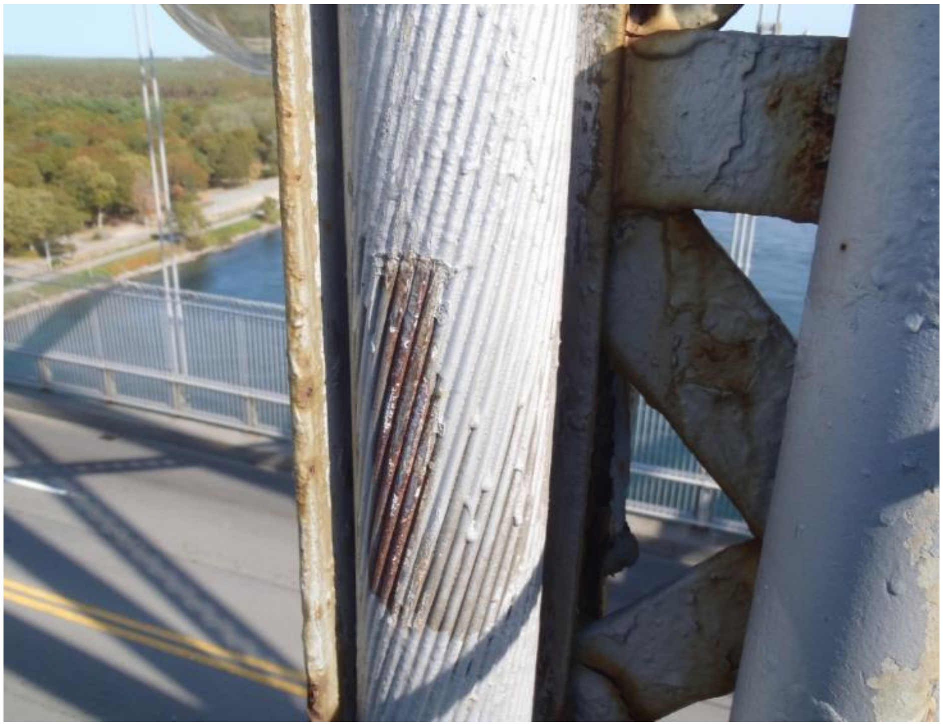


Photo 16 – Bourne Bridge, North suspender at west truss joint 13: Area of stage IV corrosion.

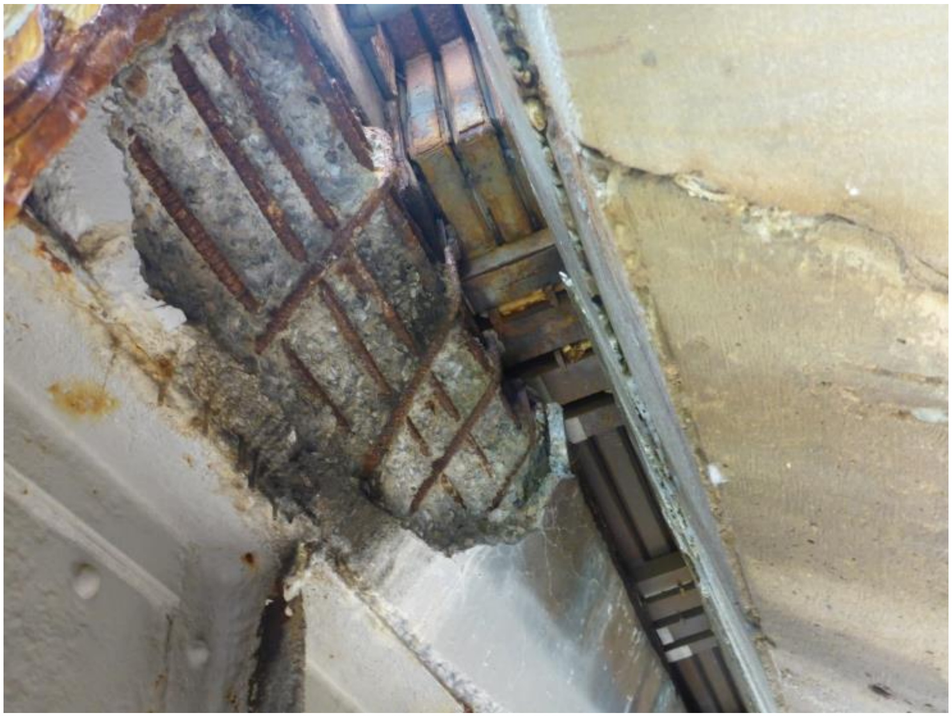


Photo 17 – Sagamore Bridge, deteriorated joint header at south abutment.

Repaired in 2018.

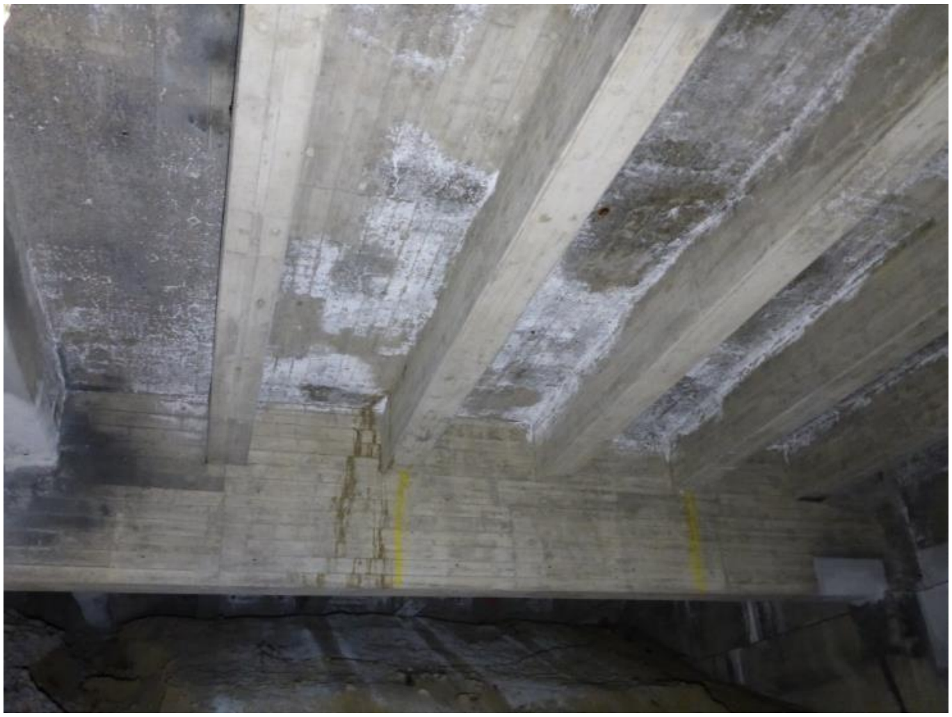


Photo 18 – Sagamore Bridge, efflorescence in the underside of the deck in chamber 1 of the south abutment.

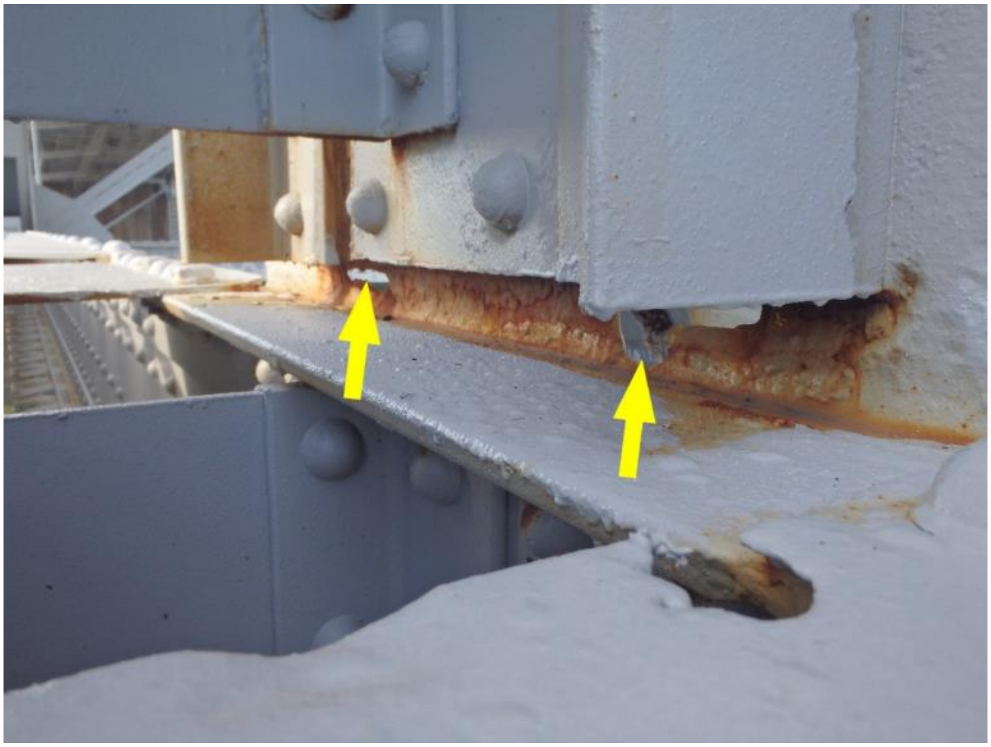


Photo 19 – Sagamore Bridge, advanced deterioration to the west gusset plate at truss joint L7 of the east truss in span 3.

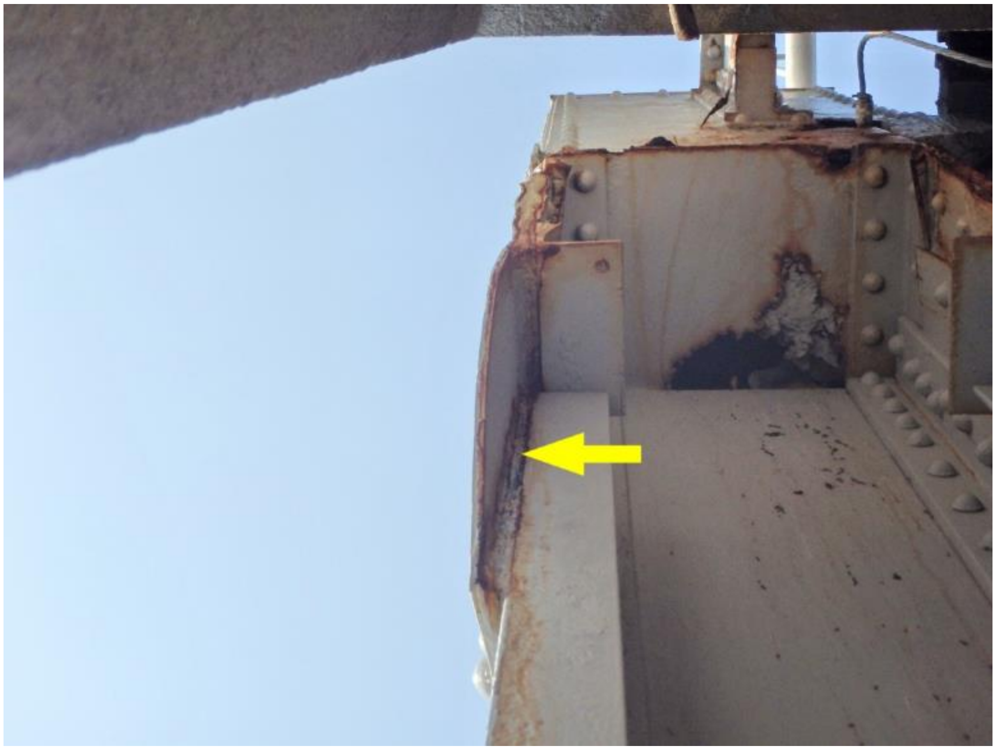


Photo 20 – Sagamore Bridge, pack rust along the north edge of truss vertical member deforming the gusset plate at truss joint U0' of the east truss.

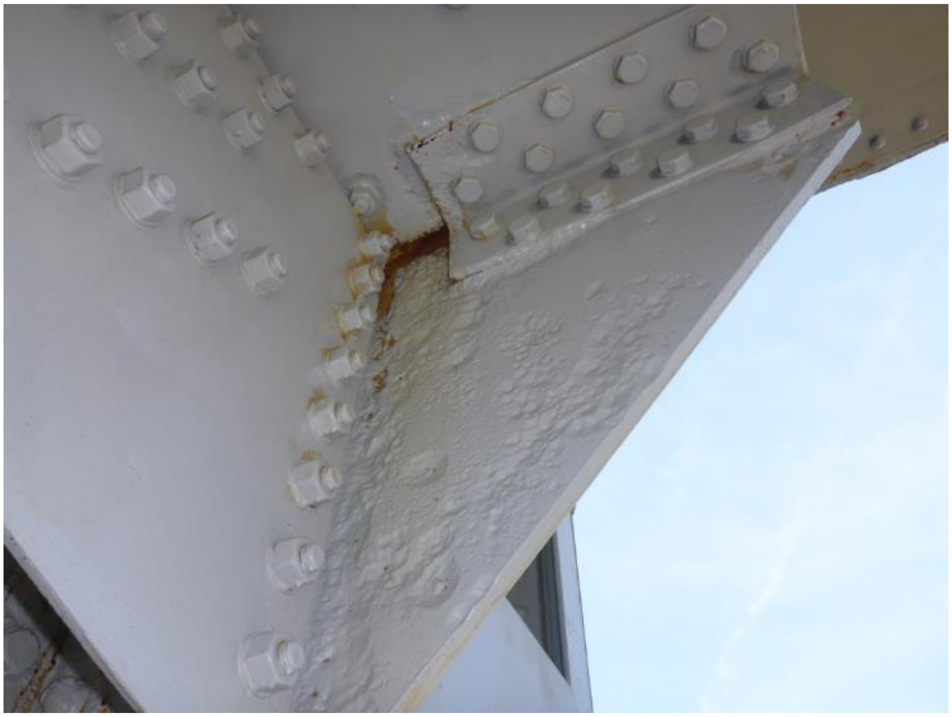


Photo 21 – Sagamore Bridge, heavy pitting on the interior face of the east gusset plate at truss joint U0 of the west truss.

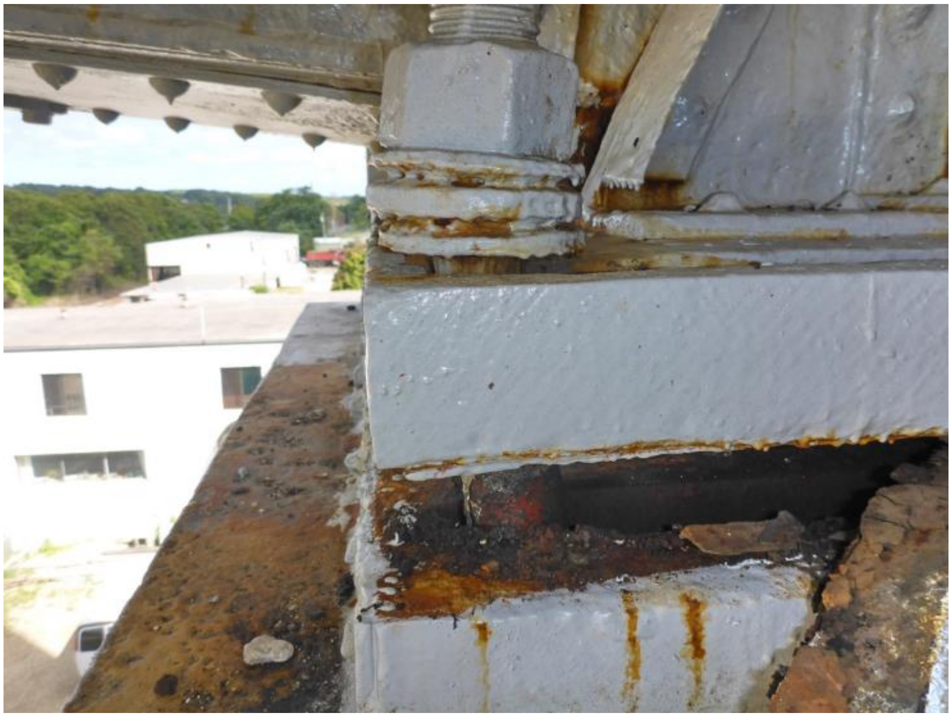


Photo 22 – Sagamore Bridge, bent anchor bolt at the south abutment out of plumb 1/4".

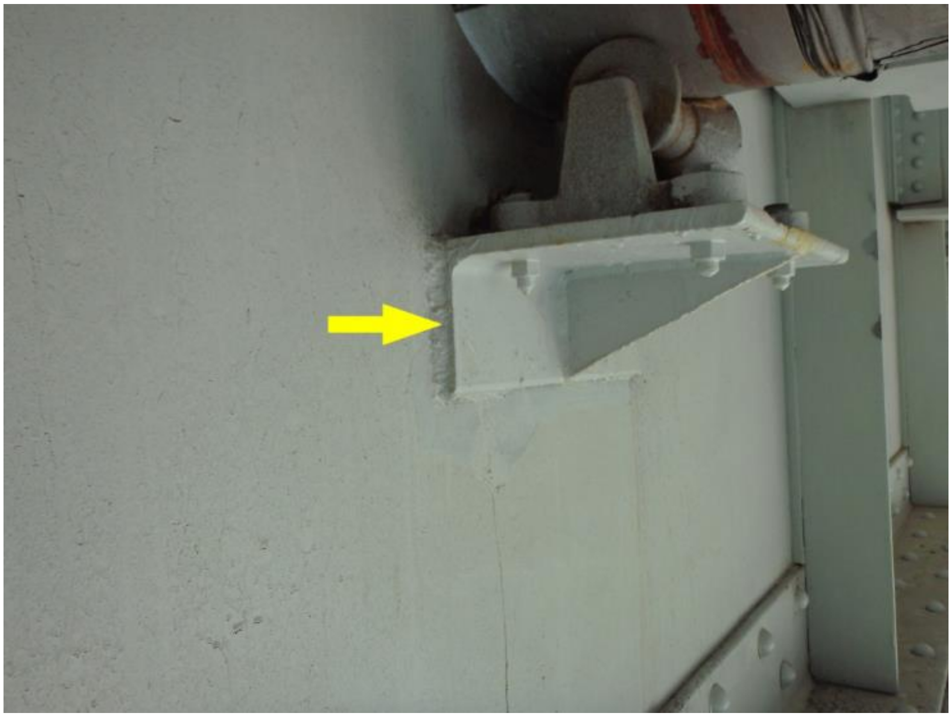


Photo 23 – Sagamore Bridge, fatigue sensitive detail utility bracket welded to the north face of the web of floorbeam FB5'.

Photo 24 – Sagamore Bridge, South Abutment on East Face exhibits an area of delaminating concrete 4’x1’ which may pose a future falling hazard.

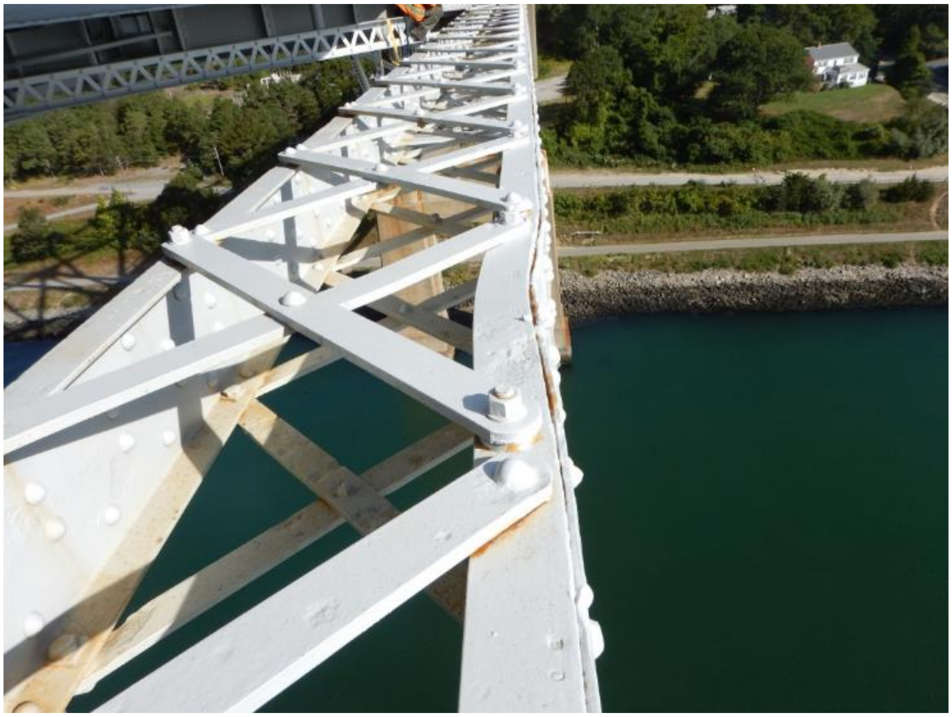


Photo 25 – Sagamore Bridge, impact damage to the east wind chord.

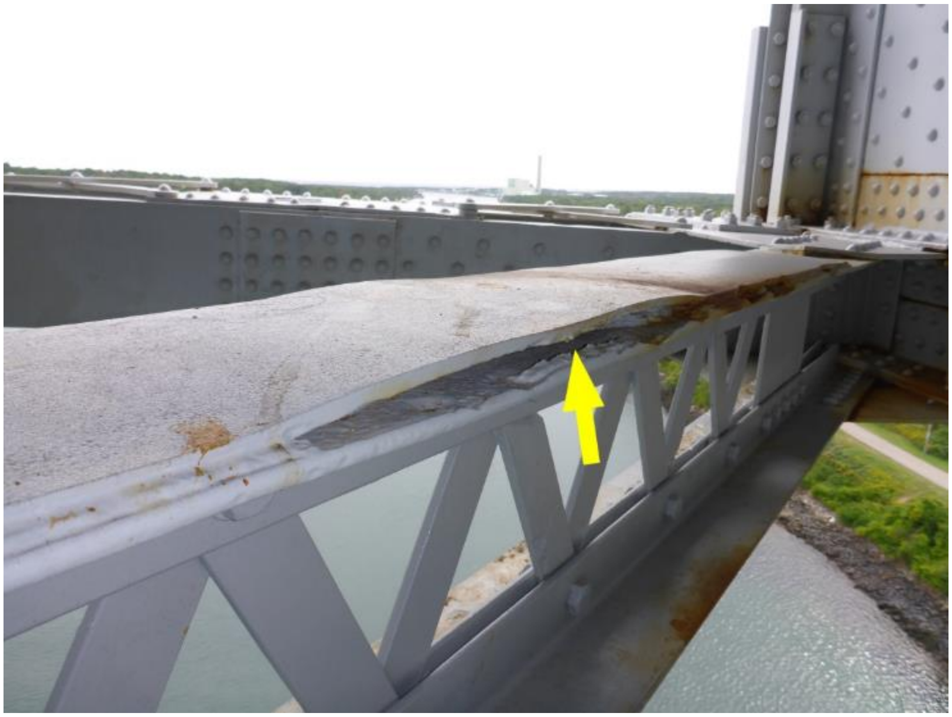


Photo 26 – Sagamore Bridge, fully cracked weld along the top flange cover plate repair.

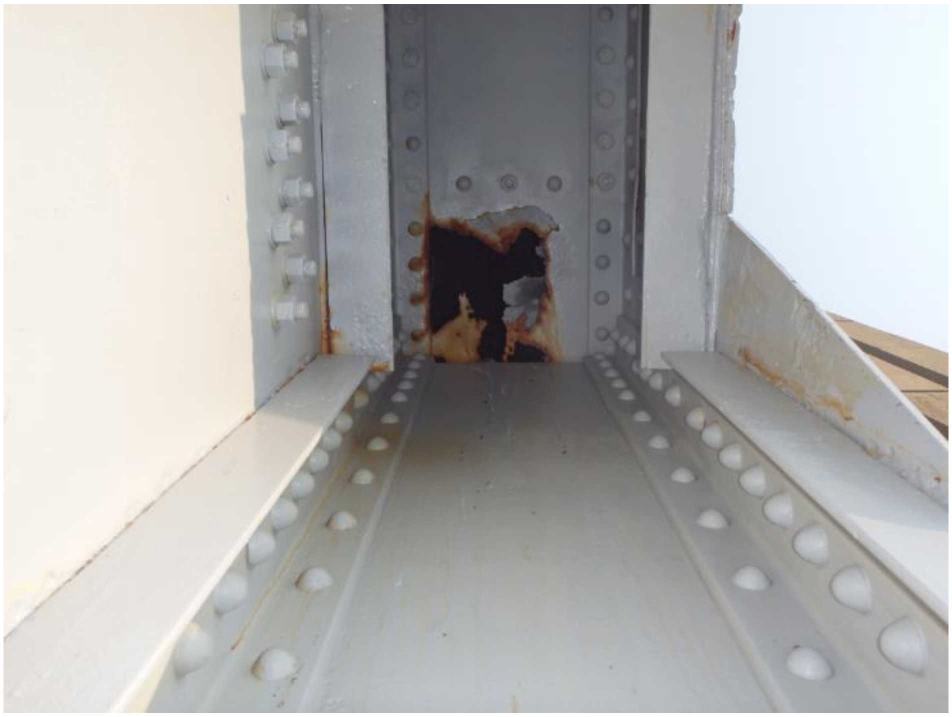


Photo 27 – Sagamore Bridge, corrosion hole in the internal longitudinal stiffener plate of east truss upper chord member U0'U1' in span 2.

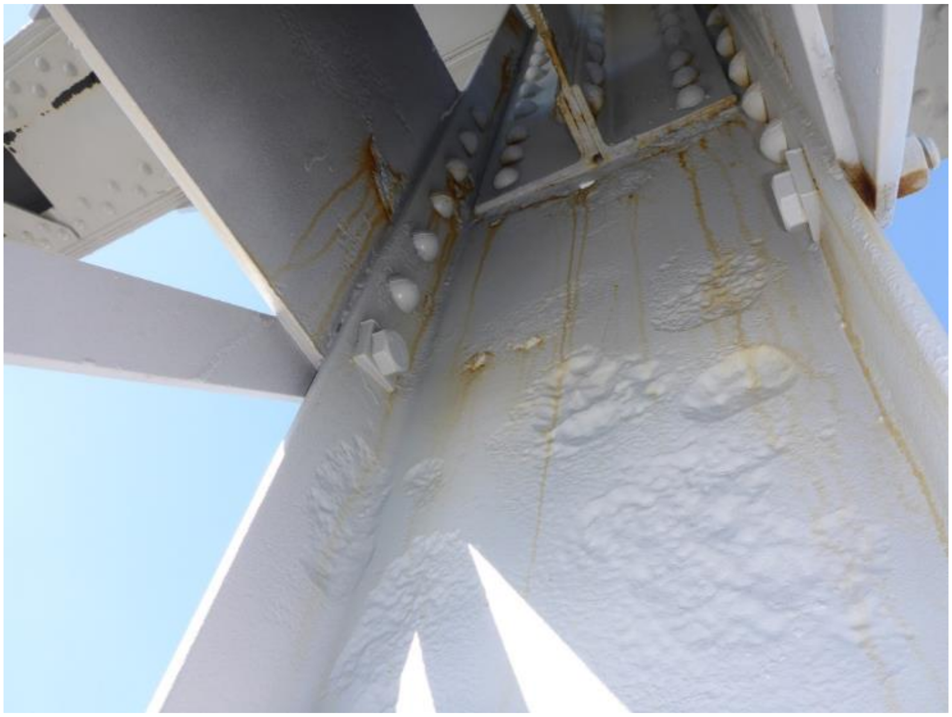


Photo 28 – Sagamore Bridge, area of pitting to the interior face of east truss vertical member in span 1.

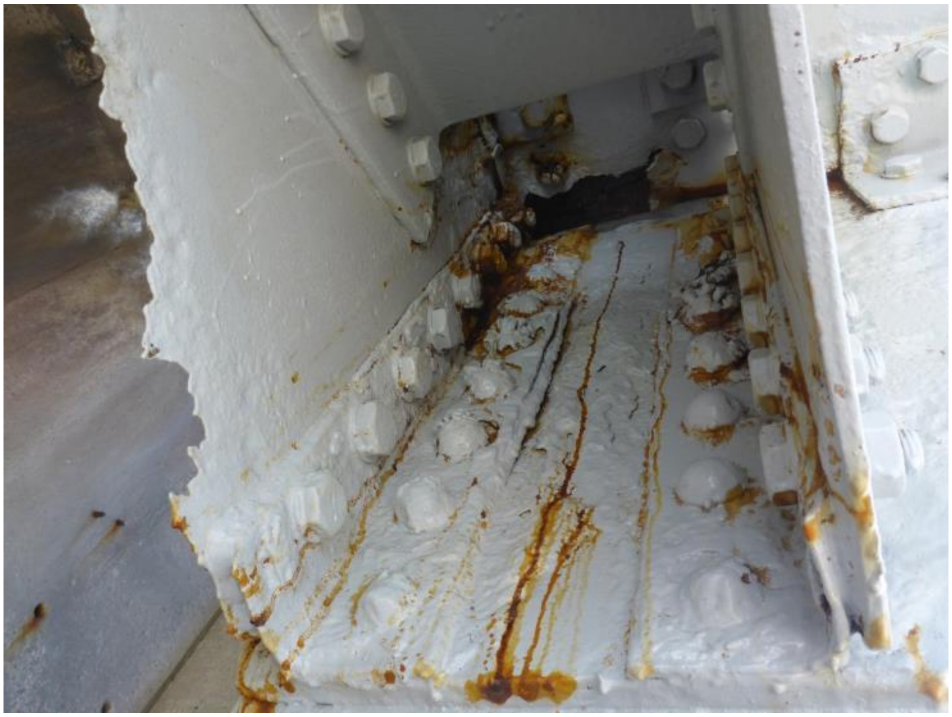


Photo 29 – Sagamore Bridge, interior view of the south connection plate of sway brace with advanced deterioration.

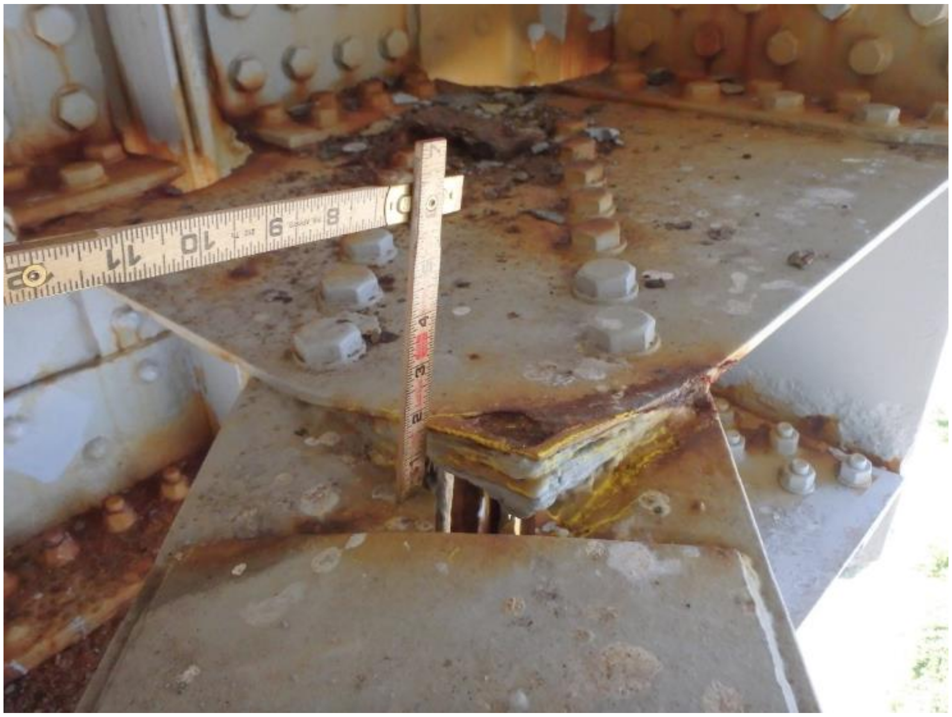


Photo 30 – Sagamore Bridge, pack rust between the upper connection plate and the upper lateral bracing between truss joints at U1 in span 3.

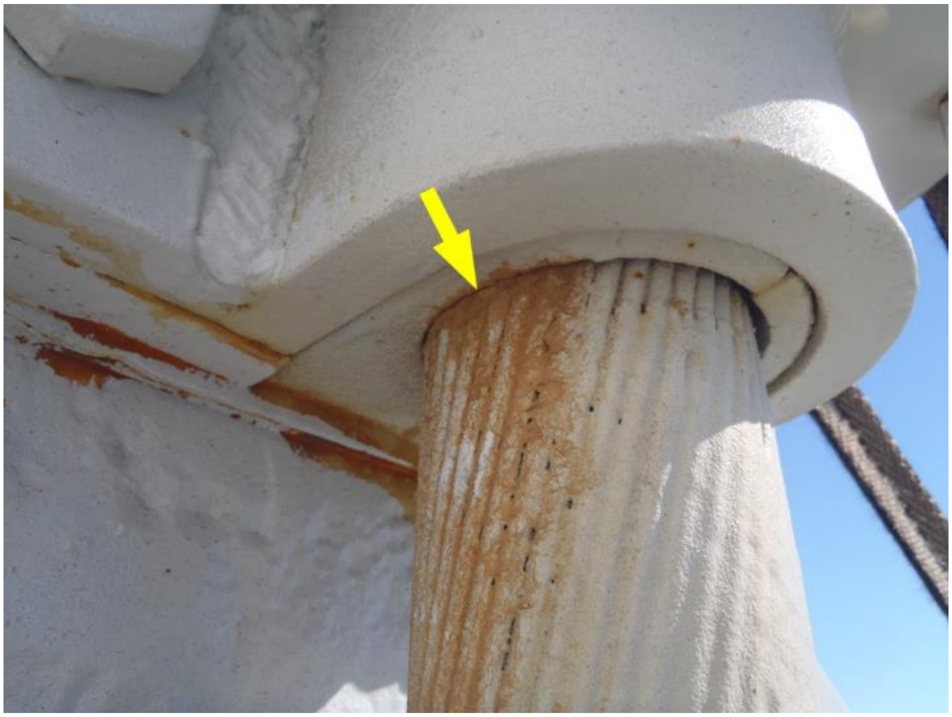


Photo 31 – Sagamore Bridge, misalignment with rubbing between the collar assembly and the south suspender cable at truss joint 15 of the east truss.

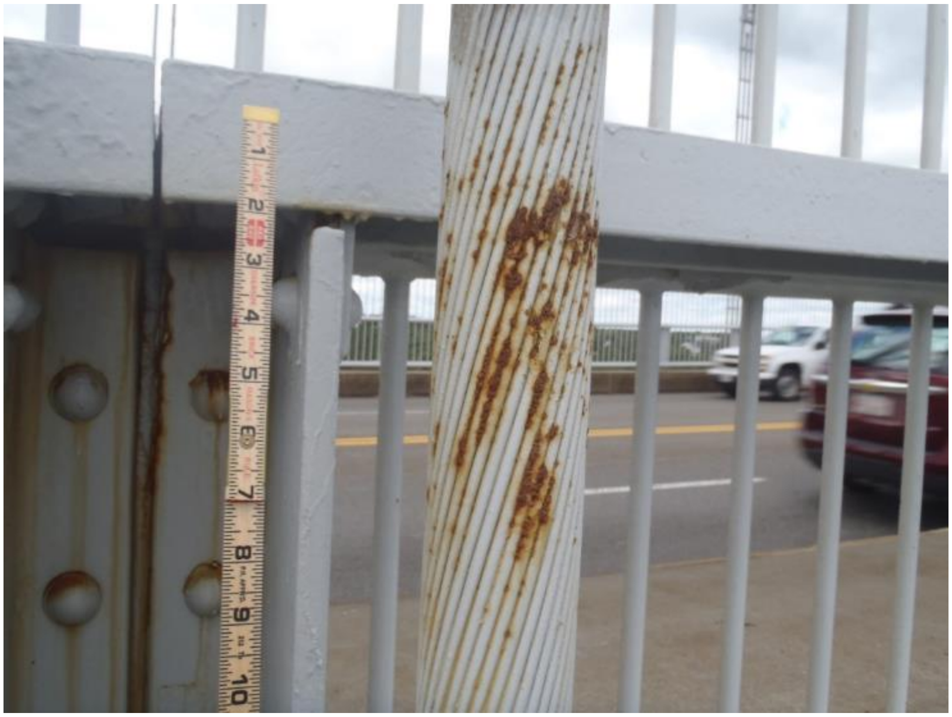


Photo 32 – Sagamore Bridge, area of stage III corrosion on the south suspender at east truss joint 12 between the top and bottom rails of the railing.

This Page Intentionally Left Blank

CAPE COD CANAL HIGHWAY BRIDGES

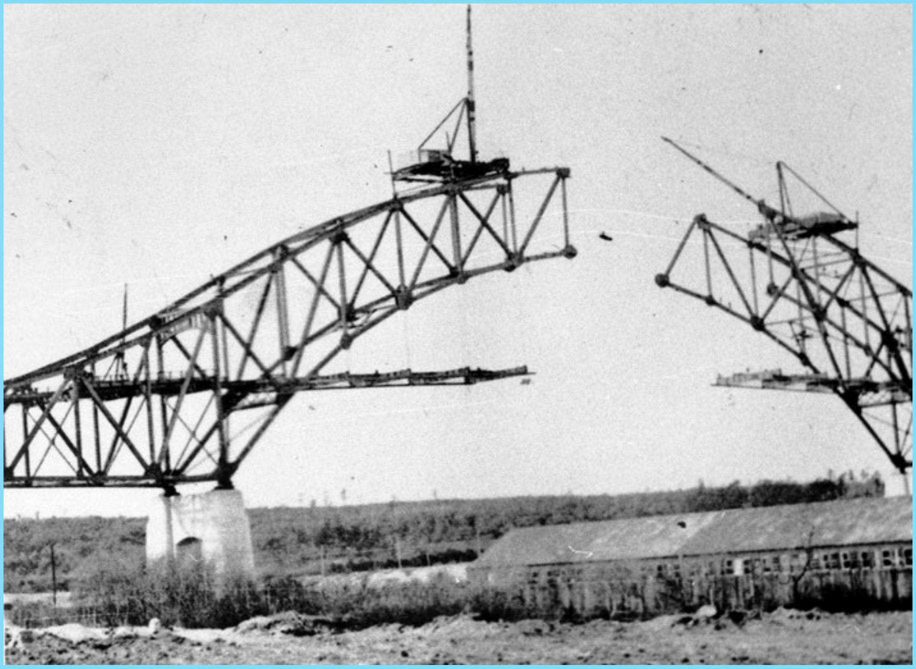
BOURNE, MASSACHUSETTS

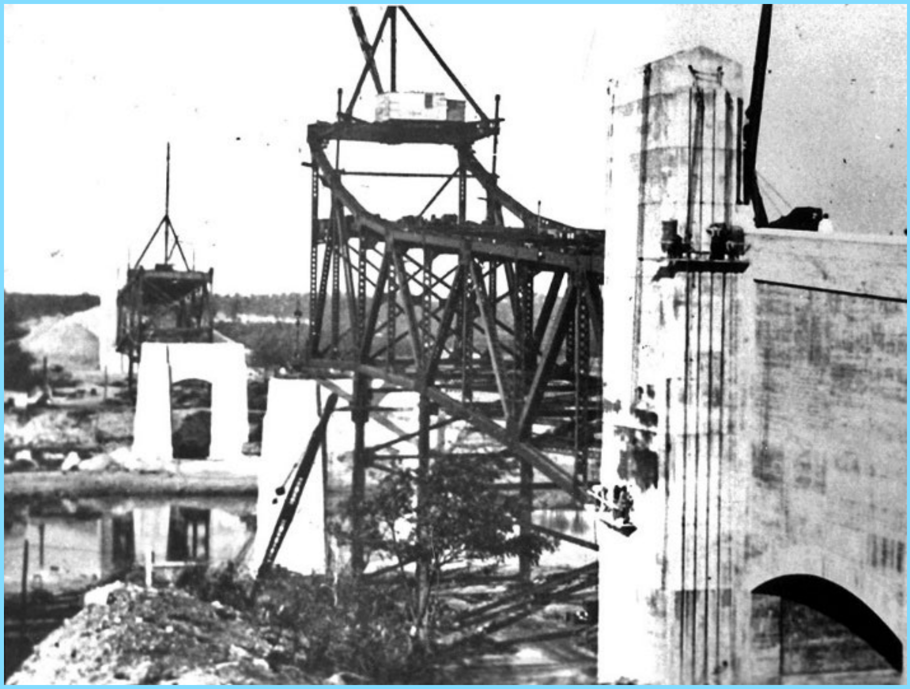
MAJOR REHABILITATION EVALUATION REPORT

APPENDIX B

PROJECT HISTORY

This Page Intentionally Left Blank





CAPE COD CANAL HIGHWAY BRIDGES
BOURNE, MASSACHUSETTS

MAJOR REHABILITATION EVALUATION REPORT

APPENDIX B – PROJECT HISTORY

Project Study, Authorization and Construction History

The route of the present Cape Cod Canal between the heads of Cape Cod Bay (formerly called Barnstable Bay) and Buzzards Bay was a trade route in colonial times as far back as the 1620s. The Massachusetts Bay Colony and later the Commonwealth of Massachusetts repeatedly studied the idea of a canal in the 1690s, 1770s, 1790s, and through much of the 19th Century. The earliest reports of surveys for a canal by the Corps of Engineers are contained in the following documents.

Report Called for by:	Report – U.S. Serial Set and Date
Act of 30 April 1824	Senate Document #32, 18th Congress, 2d Session, 14 February 1825
	House Document #174, 19th Congress, 1st Session, 2 March 1826
House Resolution of 2 January 1827	House Document #54, 21st Congress, 1st Session, 8 February 1830
Senate Commerce Committee Letter of 25 April 1870	Senate Miscellaneous Document #145, 41st Congress, 2d Session, 26 May 1870
River & Harbor Act of 3 March 1881	Senate Executive Document #104, 47th Congress, 1st Session, 14 February 1882
River & Harbor Act of 3 June 1896	House Document #311, 54th Congress, 2d Session, 24 February 1897
River & Harbor Act of 4 March 1913	House Document #1341, 63rd Congress, 3d Session, 11 December 1914

Different canal routes were considered, including a route from the Atlantic to Barnstable Bay via Nauset Harbor and Rock Harbor, routes from Nantucket Sound to Barnstable Bay via the Bass River or from Hyannis Harbor to Barnstable Harbor, and the more often examined route from Buzzards Bay to Barnstable Bay via the Monument and Scusset Rivers. While all of the aforementioned harbors were dredged by either the Commonwealth or the Corps for navigation by their local fleets, only the Buzzards Bay route was ever dredged for establishment of a canal.

On 26 June 1883 the Massachusetts legislature (Chapter 259 Laws of 1883) granted a charter to the Cape Cod Ship Canal Company for construction of a canal following the Monument and Scusset Rivers. Dredging was begun at the eastern end of the cut but was abandoned shortly afterward when funds were exhausted. The corporate charter expired without the Company completing a canal.

On 1 June 1899 the Massachusetts legislature (Chapter 448 Laws of 1899) granted another charter for construction of a canal, this to the Boston, Cape Cod and New York Canal Corporation. Activities under this charter were subject to approval by the Commonwealth through a Joint Board of Railroad and Harbor Commissioners of Massachusetts (and later the Waterways and Public Lands Commission), which reviewed and approved all plans, contracts and finances of the Canal Company. Concerning bridge crossings, Section 14 of MA Chapter 448 states that "said canal company shall provide and maintain in the towns of Bourne and Sandwich, at such points as may be designated by the county commissioners, suitable ferries or bridges across the canal, or a suitable tunnel or tunnels under the same, for passengers and vehicles, to be operated free from tolls, under reasonable rules to be established by the county commissioners, except that the canal company shall not be required to maintain a ferry if a highway bridge or tunnel shall be built at or near any of said points…." Section 15 of MA Chapter 448 states that "said company shall also construct such highways over its location to connect with the bridge or bridges, tunnel or tunnels, and ferries herein provided for, and such other highways as may be necessary to replace the highways destroyed by the construction of said canal …"

Construction of the canal began 22 June 1909 and the Canal was opened to navigation on 4 July 1914 to vessels drawing up to 12 feet. Allowable draft was increased to 20 feet in October 1915, and to 25 feet in April 1916 upon its completion. Although it was not until 25 January 1918 that the State declared the Canal completed in accordance with the company's charter. Tidal assistance was required for passage of these vessels as the canal design depth was 25 feet. The canal channel had a width of 200 to 300 feet in its seaward approaches and 100 to 150 feet through the 7.7 mile long land cut.

Three draw bridges crossed the canal, each with a horizontal clearance of 140 feet between the fenders. A highway bridge was located near the eastern end at Sagamore. A combined highway and trolley bridge was located near the western end at Buzzards Bay, and a railroad bridge was located seaward of the western highway bridge. A ferry crossing was located at Bournedale about midway between the highway bridges.

The Canal Company charter was modified three times by the legislature, as shown below.

Massachusetts Act	Purpose
Chapter 448, 16 April 1899	Act to Incorporate the Boston, Cape Cod and New York Canal Company, with Capital Stock of $6 Million, to Construct and Operate a Canal from Buzzards Bay to Barnstable (Cape Cod) Bay through the Town of Bourne or Sandwich or Both, including such Lands, Highways, Bridges, Tunnels, Breakwaters, Wharves and Vessels as Needed or Required. Company shall Pay Damages for taking and Relocating Railroads and Railroad Crossing. Creates a Joint Board consisting of the Land and Harbor Commission and the Railroad Commission to Review and Approve all Plans, Contracts and Bridge Crossings with Suitable Draw Spans. The Joint Board would Determine of Highway Bridges, Railroad Bridges and Ferries, and Highways and Railroad Lines within the Canal Company Lands.

	Section 14 – Canal Company to Provide and Maintain Highway Bridges, Ferries or Tunnels (and Highways to Connect with such – Section 15) in the Towns of Bourne and Sandwich at Points Determined by the County Commissioners and Free from Tolls. A Ferry will not be Required at any Point where a Bridge or Tunnel has been Provided.
Chapter 476, 17 July 1900	Provides that the Commonwealth may Purchase the Canal by paying the Company the Cost of its Investment and Bonds plus Ten Percent.
Chapter 519, 13 May 1910	Provides that the Joint Commission Created by Chapter 448 (1899) as Amended may Change the Points as it Previously Determined for the Railroad and Highway Crossings of the Cape Cod Canal, and Provided that the Canal Company Five Years from the Date of Enactment to Complete Construction of the Canal.
Chapter 184, 16 April 1917	Creates a Joint Commission consisting of the Commissioners of Public Service and Waterway & Public Lands, the Commissioners of Barnstable County, and the Selectmen of the Towns of Bourne and Sandwich. The Commission may order the Discontinuation of the Bournedale Ferry Service, and may Amend, Modify, or Revoke any Order made under Chapter 448 (1899) as Amended for Construction and Maintenance of a Bridge, Ferry or Tunnel at Bournedale. Provided that a Street Railway Service be First Constructed and Operated along the North side of the Canal between Sagamore, Bournedale and Bourne Villages.

With private construction of the canal underway, Congress again took an interest in the matter and began calling for reports on the subject. The River and Harbor Act of 4 March 1913 called for a report on improving the western approach to the canal, including the removal of Cleveland Ledge. The responding Preliminary Examination, 11 December 1913 and Survey Report, 30 September 1914, both printed in House Document #1341, 63rd Congress, 3d Session, 11 December 1914 were unfavorable to such work as these obstructions were considered easily avoidable by ships transiting the canal.

The River & Harbor Act of 4 March 1915 called for a study of providing a harbor at Onset Bay connected to the western end of the Canal. The responding Preliminary Examination, 5 November 1915, as printed in House Document #810, 64th Congress, 1st Session, 1 March 1916, was unfavorable to adopting such a project, but that issue would be revisited once the canal was acquired by the Federal Government.

Senate Document #279, 65th Congress, 2d Session, 24 September 1918, prepared near the end of World War I (called for by Senate Resolution of 5 July 1918), contains reports on three east coast canals including the Cape Cod Canal. The report by the Department of Commerce, Bureau of Foreign and Domestic Commerce, provides a discussion of the history, development, operation, national defense needs, and features of the three canals and provides estimates for their improvement and takeover by the United States. The report states that on 22 July 1918 possession of the Cape Cod Canal was placed under the control of the Director General of

Railroads by a Presidential Proclamation 1419, 26 December 1917 (40 Stat. 1808), and that operation of the canal was entrusted to the United State Railroad Administration (USRA).

These actions were taken under authority in Section 1 of the Army Appropriations Act of 29 August 1916 (39 Stat. 645) which gave the President power, in time of war, "to take possession and assume control of any system or systems of transportation, or any part thereof, and to utilize the same, to the exclusion as far as may be necessary of all other traffic thereon, for the transfer or transportation of troops, war material and equipment, or for such other purposes connected with the emergency …". Under this authority the USRA took control and operated railroads, coastwise steamship lines, inland waterways, and telephone and telegraph companies seized in the interest of national defense, and entered into compensatory agreements with seized carriers and utilities pursuant to the Federal Control Act of 21 March 1918 (40 Stat. 451). The USRA began operating the Canal on 25 July 1918 and proceeded with maintenance dredging of the Canal to return its controlling depth to the 25-foot design depth. The railroads and other seized properties and concerns were returned to private control on March 1, 1920, under terms of the Transportation Act of 28 February 1920 (41 Stat. 470), and the USRA commenced with liquidation and final settlement of accounts with the owners. Congress however was concurrently examining Federal acquisition of both the Cape Cod and the Chesapeake and Delaware canals, and called for additional studies.

House Document #1768, 65th Congress, 3d Session, 6 February 1919, contains reports on the cost and advisability of purchase and enlargement of the Cape Cod Canal by the Federal Government, as called for by the River and Harbor Act of 8 August 1917 (40 Stat. 250, P.L. 65-37). That Act called on the Secretaries of the Navy, War and Commerce to examine the Canal, appraise its value, make a recommendation for its purchase, and begin negotiations with the owners for its purchase. The reports also included a recommendation to deepen the canal to 30 feet and widen the land cut channel to 200 feet. The Canal Company declined the Government's initial offer of $8,250,000 for the Canal and made a counter-proposal for $13 million. In House Document #1812, 65th Congress, 3d Session, 17 February 1919, (and Senate Report #761, 65th Congress, 3d Session, 25 February 1919), letters from the Railroad Administration and Secretary of War to Congress were printed. The Railroad Administration stated that with the end of the U-Boat threat to shipping that its operation of the Canal was no longer justified. The Secretary of War requested authorization to take possession of the Canal once condemnation proceedings were completed. Proposed language authorizing the purchase not to exceed $10 million was printed in House Document #68, 66th Congress, 1st Session, 2 June 1919.

The Government began condemnation proceedings in U.S. District Court for Massachusetts, and a jury verdict (18 November 1919) set a price of $16.8 million minus $150,000 for maintenance performed by the Railroad Administration. On 1 March 1920 the Federal Government relinquished control of the Canal and attempted to return it to the Canal Company. The Company initially refused to accept return, but agreed to operate the Canal while negotiations continued and to turn-over a portion of excess revenues to the Government (Senate Report #924, 68th Congress, 2d Session, 22 January 1925). On appeal the U.S. 1st Circuit Court set aside the November 1919 judgment (16 February 1921) for error and ordered a new trial.

The Secretary of War and the Canal Company then agreed on a price of $11.5 million on 21 July 1921 and executed a contract on 29 July 1921. House Document #139, 67th Congress, 2d

Session, 12 December 1921 prints letters from the Secretary of War and the Bureau of the Budget, and the proposal from the Canal Company. The purchase was to be $5.5 million cash, plus $6 million for the Government's payment on the value and interest on the Company's bonds. The Canal Company continued operation of the Canal pending Congressional ratification of the purchase contract.

Between 1921 and 1927 Congress repeatedly took up the issue of purchasing the Canal. Numerous hearings were held and bills and committee reports drafted. Concern was expressed with the post-war fiscal limitations, Government interference in commerce, and Federal assumption of business debts. A selection of committee reports outlining the differing House and Senate views on these issues includes:

House Report #1016, 67th Congress, 18 May 1922
House Report #181, 68th Congress, 11 February 1924
Senate Report #924, 68th Congress, 22 January 1925

The River and Harbor Act of 21 January 1927, Section 2 (44 Stat. 1010, P.L. 69-560, H.R. 11616) ratified the contract for purchase of the Canal with certain stipulations limiting the start date for the period for which the Government was responsible for payment of interest on the Company's bonds, plus a requirement for a joint general release of claims by the Government and the Company. The purchase price remained $5.5 million cash, plus $6 million for principal and interest on the bonds, as specified in House Document #719, 69th Congress, 2d Session, 15 February 1927. The first Deficiency Appropriations Act for Fiscal Year 1928, 22 December 1927 (45 Stat.2, P.L.70-2) appropriated the $5.5 million for the cash portion of the purchase. The Second Deficiency Appropriations Act for Fiscal Year 1928, 29 May 1928 (45 Stat.883, P.L.70-563) appropriated the $6 million for the assumption of the Company's bond debts including interest, as specified in House Document #221, 70th Congress, 1st Session, 10 April 1928. Title to the Canal was to pass to the Government on 1 January 1929, although the Government had assumed control and operation of the Canal on 31 March 1928. At that time tolls ceased and the Corps began operation of the canal, bridges and ferry, with maintenance dredging beginning that July (Annual Report of the Chief of Engineers, 1929).

The River and Harbor Act of 3 July 1930 (46 Stat. 918, P.L. 71-520) directed a study be made of the Cape Cod Canal. The reports of the preliminary examination and survey report are printed in House Document #795, 71st Congress, 3d Session, 3 March 1931, and made the following recommendations:

Project Features	District Engineer Recommendations	Division Engineer Recommendations	BERH Recommendations
Channel Depth	35 feet	32 Feet	30 Feet
Locks	2 Locks 110 x 1000 feet, 40 feet over sills	2 Locks 110 x 1000 feet, 40 feet over sills	1 Lock 110 x 1000 feet, 40 feet over sill
Land Cut Width	300 feet	300 feet	250 feet
Sea Cut Width	500 feet	500 feet	400 feet
Channel Width Seaward of Wings Neck with a Straighter Alignment	700 feet	700 feet	700 feet
Highway Bridges	One fixed high-level	One fixed high-level	One fixed high-level
Railroad Bridge	One new drawspan	One new drawspan	One new drawspan
Small craft harbors	Harbor of Refuge at East end and 15-foot harbor at Onset Bay	Harbor of Refuge at East end and 15-foot harbor at Onset Bay	15-foot harbor at Onset Bay

.

The Chief of Engineers concurred in the recommendations of the Board of Engineers for Rivers and Harbors. These reports cite a peak summer bridge traffic volume of "more than 1000 cars per hour over each bridge." Plans for a new highway crossing considered a central location for either a new single six-lane high-level fixed highway bridge or a single tunnel. It was also considered that the proposed single high-level highway bridge might also include a railroad deck, but absent that a new railroad bridge with movable span and greater horizontal channel clearance would be needed. A statement of traffic volumes for the two highway bridges from the 1930 survey report is as follows:

Winter average daily number of cars	1,200
Winter average monthly number of cars	36,000
Summer average daily number of cars	4,700
Summer average monthly number of cars	142,000
Summer peak Sunday number of cars	9,400

Concerning the Bournedale Ferry, the Survey Report included in House Document #795 contains the following information (page 27). "Among the inheritances received by the United States from the canal company was the operation of the Bournedale Ferry, about a mile and a quarter west of the Sagamore Bridge. The company, when arranging for the right of way, found that the canal would cut across a local road leading to the Bournedale railroad station (now abandoned) and vicinity, and used principally by persons of the immediate neighborhood. … The company was accordingly obliged to establish and operate a free ferry, and under the general terms of the agreement for purchase, the United States assumed the obligation." The ferry had carried more than 4,700 passengers in 1929, down from 34,800 in 1919. The survey report concluded that accommodation of foot traffic serviced by the ferry could be met by providing for such in the planned centrally located high-level highway bridge or by a walkway across the lock to be built near Bournedale.

The 1930 Survey Report included in House Document #795 also discusses the Government's obligation to provide a railroad bridge (page 90), and the assumption of the responsibilities of the Canal Company for the construction and maintenance of the railroad bridge and its lighting and signaling. The report states that "the assumption of these obligations by the United States as a part of its purchase of the canal was approved by the Chief of Engineers on May 4, 1928, thus the upkeep and operation of the bridge and of a portion of its appertaining signal system are paid for by the United States …"

The Annual Report of the Chief of Engineers for 1933 states that "the construction of bridges over the canal and widening as recommended in House Document #795 … have been included in the Public Works Program (Federal Emergency Administration of Public Works) under the National Industrial Recovery Act appropriations for Fiscal Year 1934." The National Industrial Recovery Act, 73rd Congress, 1st Session, 16 June 1933 (P.L. 73-67) declared the financial situation to be a national emergency, and was enacted to "encourage national industrial recovery, foster fair competition and for construction of certain public works." Much of Title I of this Act was later ruled unconstitutional by the US Supreme Court (May 1935). Title II authorized the President to create new agencies, specifically the Federal Emergency Administration of Public Works (the Public Works Administration). The PWA and its appropriations were used to fund a wide range of programs and projects, including construction of river and harbor improvements and flood control projects, and for military purposes. The PWA would be used to initially authorize improvements to the Cape Cod Canal, including the three new bridges and the deepening and widening of the channel.

That Annual Report for 1933 also states that the Bournedale Ferry service was discontinued on 15 August 1932. The Annual Report for 1934 states that construction of two high-level four-lane highway bridges commenced on 8 December 1933, with construction of the new vertical lift railroad bridge beginning on 18 December 1933. The annual reports for these and the next several years separately account for improvement work done for the Cape Cod Canal with PWA funds, and regular Civil Works funds, as well as civil work operations and maintenance work.

House Committee on Rivers and Harbors Document #15, 74th Congress, 1st Session, 26 December 1934, prints a report of the Chief of Engineers dated 26 December 1934, a report of the BERH dated 10 December 1934, and reports of the Division and District Engineers dated 19 November and 24 October 1934, respectively, on a review of the recommendations made in 1931 in House Document #795. The report recommended eliminating the tidal lock to allow for a sea level canal with a channel depth of -32 feet, 700 Feet Wide from Deep Water in Buzzards Bay to Wings Neck, then 500 Feet Wide Inward from Wings Neck and 540 Feet Wide through the Land Cut with Stone Revetments, two mooring basins; one 2,000 feet long along the north bank near the east entrance, and the other 1,000 feet long in Buzzards Bay north of Hog Island along the southeast channel limit. Also recommended was a small boat harbor at Onset Bay consisting of a channel -15 feet MLW by 100 feet wide by 4,340 feet long from the canal channel into the Bay. This report also states that "the obligations imposed on the United States in acquiring the canal prevented the substitution of a single highway bridge for the two present crossing and two fixed highway bridges are therefore being constructed with a clear span of 550 feet and a vertical clearance of 135 feet above high water. A new railroad bridge with a vertical lift of 500 feet span, affording a clearance of 135 feet above high water is also being constructed." The estimate for future operation and maintenance of the canal included in these reports and recommendations included maintenance of the bridges then under construction.

The Emergency Relief Appropriations Act, 74th Congress, 1st Session, 8 April 1935 was passed as Joint House and Senate Resolution making appropriations for emergency relief purposes. This New Deal legislation transferred direct relief efforts from the Federal Government to the states and local governments and appropriated $4.88 billion to fund the Public Works Administration. No projects were specifically named, and funds were allocated to a wide range of projects and programs, including highways, bridges and rivers and harbors projects. This appropriation was the source of funds for constructing the Cape Cod Canal high-level highway bridges and the new railroad lift span, and beginning dredging to widen (to 205 feet) and deepen the Canal channel, relocate and straighten the Buzzards Bay approach channel, and provide additional rip-rap bank protection in the land cut.

The improvements recommended in HCR&H Document #15 were authorized by the River & Harbor Act of 30 August 1935, 74th Congress, 1st Session (P.L. 74-409). The recommendation was for "an open canal 32 feet deep, 540 feet wide in the land cut, 500 feet wide in the new straight channel to Wings Neck, and 700 feet wide beyond Wings Neck, a 15-foot channel into Onset Bay 100 feet wide, mooring basins at each end of the canal at locations and dimensions to be determined by the Chief of Engineers, all at an estimated cost of $25,875,000 (excluding cost of new bridges and widening from 170 to 205 feet) with $400,000 annually for operation, care and maintenance, which shall include maintenance of the new bridges now under construction." Construction of these improvements, some of which were already underway in 1935 using PWA funds appropriated in Fiscal Year 1934 by the NIRA Act, would be completed in 1940. The mooring basin sizes were further modified during construction with final dimensions as follows: East Basin - 2,500 feet long by 350 feet wide by -25 feet MLW, West Basin - 3,300 feet long by 350 feet wide by -32 feet MLW. Work of removing the old draw span highway bridges began with the old Sagamore Bridge in June 1935 after completion of the new bridge and its approach roads. The removal of all three old bridges and their piers was completed by July 1936.

The Annual Report for 1937 states that "by date of 1 July 1935, under Authority of the Permanent Appropriations Repeal Act of 26 June 1934, operation and maintenance of the Canal were included in the authorized project." The text of the 1934 PAR Act specifically speaks to the Cape Cod Canal only in terms of including the payment of the Canal bonds now being subject to annual appropriations action by Congress, instead of continuing appropriations from the general fund of the Treasury. However, also included in the Act was language that required "operating and care of canals and other works of navigation", also be subject to specific annual appropriations.

The 15-foot Onset Bay small craft channel was initially completed in Fiscal Year 1937. The outer end of the channel was realigned in May to June 1940. In May to June 1957 the Onset Bay channel was extended to the Town Wharf where a 15-foot turning basin and 8-foot anchorage were also dredged, as recommended in House Document #431, 77th Congress, 1st Session, 7 November 1941, and as authorized by the River and Harbor Act of 2 March 1945 (P.L. 79-14).

Improvement dredging of the -13-foot MLW outer section of the East Boat Basin at Sandwich, and the 18-foot West Boat Basin at Bourne, was accomplished between August 1938 and March

1939. Expansion of the East Boat Basin by adding an inner 4.3-acre by -8-foot MLW area was dredged in July 1962 to April 1963, as recommended in House Document #168, 85th Congress, 1st Session, 29 April 1957, and as authorized by the River & Harbor Act of 3 July 1958.

The first repainting and resurfacing of the highway bridges was carried out in the summer of 1938. The first repainting of the Buzzards Bay Railroad Bridge was carried out in May to July 1940.

In summary, as pertains to the highway crossings of the Cape Cod Canal, the Corps has the authority to operate and maintain two highway bridges at Sagamore and Bourne villages, of four travel lanes each, with pedestrian access, and with suitable connection over Federal lands to approaches and highways.

Tables showing the authorization history, and the construction and maintenance history, for the Cape Cod Canal Federal Navigation Project and its associated small boat harbors follow.

CAPE COD CANAL
BOURNE, WAREHAM & SANDWICH, MASSACHUSETTS
LIST OF AUTHORIZATIONS

Authorization	Work Authorized & Constructed	Construction
25 July 1918	US Railroad Administration began to Operate the Canal, Pending Owner's Bankruptcy and Dredged Shoals to Restore the -25 Foot Depth	Federal Take-over of Canal Operations
River & Harbor Act of 21 January 1927	Purchase from the Boston, Cape Cod and New York Canal Company Authorized – At Purchase Canal had Dimensions of -25 Feet MLW by 100 Feet Wide through Land Cut. Design of Bank Revetments began. Possession Taken 31 March 1928	Federal Purchase of Canal Project First US Maintenance August 1928
Public Works Administration Program in the National Industrial Recovery Act of 6 September 1933	Widen Canal Land Cut to 205 Feet and Construct 3 Bridges – A Railroad Bridge – 544 Foot Long Single Track Vertical Lift Span with Closed Vertical Clearances of +7 Feet mhw and 135 Feet MHW Raised, and Horizontal Clearance of 500 Feet and Two 4-Lane High Level Fixed Span Highway Bridges with Vertical Clearance of 135 Feet mhw and 500-Foot Horizontal Clearance.	Land Cut Widening: Oct 1932 - March 1936 Railroad Bridge: Dec 1933 – Dec 1936 Highway Bridges: Dec 1933 - 1935
Permanent Appropriations Repeal Act of 26 June 1934	Authorizes Future O&M Activities on Improvements Authorized by Corps Legislation Only (Also Chief of Engineer's Letter, 1 July 1935)	Future Maintenance Authorized

National Industrial Recovery Act of 6 September 1933	Channel -30 Feet MLW by 500 Feet Wide in Seward Portions and 205 Feet Wide in the Land Cut, the Channel through Buzzards Bay to Follow a Straightened Route Westerly of Mashnee Island with an Increased Width of 700 Feet Beyond Wings Neck, with a Channel -15 Feet MLW into Central Onset Bay for Small Craft Refuge and with 150 Feet Vertical Clearances for the 2 Highway Bridges and a Level Grade Vertical Lift Span Railroad Bridge.	Authorization was Superseded by the Two 1935 Acts
Emergency Relief Act of 28 May 1935	Authorized Dredging and Bank Protection Measures	See Next Entry
River & Harbor Act of 30 August 1935 and Emergency Relief Appropriations Act of 8 April 1935	(1) Eliminating the Tidal Lock from the Authorized Design and Substituting an Open Sea Level Canal -32 Feet MLW by 700 Feet Wide from Deep Water in Buzzards Bay to Wings Neck, then 500 Feet Wide Inward from Wings Neck and 540 Feet Wide through the Land Cut with Stone Revetments and (2) a Channel -15 Feet MLW by 100 Feet Wide by 4,340 Feet Long into Central Onset Bay to Provide a Harbor of Refuge for Small Craft, (3) Two Mooring Basins, One along the North Bank Near the East Entrance 2,500 Feet Long by 350 Feet Wide by -25 Feet MLW and the other in Buzzards Bay North of Hog Island along the Southeast Channel Limit 3,300 Feet Long by 350 Feet Wide by -32 Feet MLW, (4) Accessory Facilities and Features Including Lighting, Aids to Navigation and Operations Facilities, (5) Two Fixed Span Highway Bridges Each with a 150 Foot Vertical Clearance, and (6) a Level Grade Vertical Lift Span Railroad Bridge.	32-Foot Channel: Aug 1935 – Nov 1939 Onset Bay Channel: July 1936 – FY 1937 18-Foot West Boat Basin: Aug 1938 – March 1939
Public Works Administration, 29 April 1935, under the Authority of the National Industrial Recovery Act of 6 September 1933	Construction of the East Boat (Mooring) Basin	East Boat Basin: Aug 1938 – March 1939

River & Harbor Act of 2 March 1945	Onset Bay - Extend the 15-Foot Channel 3,560 LF Upstream 150 Feet Wide to a 15-Foot 7.1 Acre Turning Basin (460 by 550 Feet) at the Town Wharf about, and Two 8-Foot Anchorage Areas - 5.1 Acres East of the Basin and 10.2 Acres South of the Basin and West of the Channel	May 1957 – June 1959
River & Harbor Act of 30 June 1948	Buttermilk Bay - Channel -7 Feet MLW by 100 Feet Wide Across the Outer Bar from off Taylor Point to Sears Point, Widened at the Bend	Nov 1952 – Jan 1953
River & Harbor Act of 3 July 1958	Expansion of the East Boat Basin to a Total Area of 7 Acres by Adding 4.3 Acres at -8 Feet MLW	July 1962 – April 1963
Water Resources Development Act of 1986, Section 1002	Deauthorized Raising the Inshore End of the South Jetty at the East Entrance to the Canal as Authorized by the River & Harbor Act of 1960 as Part of the Town Neck Beach Erosion Control Project	Deauthorization
Water Resources Development Act of 8 November 2007, P.L. 110-114, §1004(a)(8)	Directed a Study, and if Found Feasible, Implementation of Improvements to the East Boat Basin, Cape Cod Canal, under Section 107 Authority	Never Acted On – Study Terminated at Sponsor Request
America's Water Infrastructure Act, 23 Oct 2018 (PL 115-270) 132 Stat. 3765 §1315	States that the Secretary May Repair or Replace as Necessary, any Bridge Owned or Operated by the Secretary that is in New England and Necessary for Evacuation during an Extreme Weather Event	

CAPE COD CANAL, BOURNE, WAREHAM & SANDWICH PROJECT CONSTRUCTION & MAINTENANCE HISTORY		
Work Dates	**Work Accomplished**	**Quantities**
1918 - 1927	US Railroad Administration has Operated the Canal Since 25 July 1918 and has Dredged Shoals to Restore the -25 Foot Depth.	Unknown
August 1928	Maintenance Dredging of 25-Foot Land Cut West of Sagamore Bridge	7,795 cy
Sept 1928 – FY30	Maintenance Dredging of 25-Foot Channel by US Dredge *Minquas* beginning at the East Entrance and Proceeding West	637,156 cy
Nov 1929 – Feb 1930	Maintenance Dredging of 25-Foot Buzzards Bay Approach Channel by US Dredge *Marshall*	340,177 cy
FY 1931 – FY 1932	Maintenance Dredging of 25-Foot Channel by US Dredge *Minquas*	630,450 cy
FY 1931 – FY 1932	Placement of Riprap Bank Protection along Land Cut Slopes	29,118 Tons Stone
July 1932 – Sept 1932	Construction of an 18-Inch Concrete Drain on the South Bank at the East End of the Canal	NA
Aug 1932 – Sept 1932	Maintenance Dredging of Hard Shoals at the Eastern End of the Canal	12,099 cy Plus 27 cy Boulders
FY 1933	Maintenance Dredging of 25-Foot Channel by US Dredge *Minquas*	396,790 cy
Oct 1932 – March 1933	Begin Improvement Dredging to Widen 25-Foot Channel Land Cut from the Eastern Entrance Proceeding Westerly	660,244 cy Plus 1,763 cy Boulders
June 1933 – Dec 1933	Continue Improvement Dredging to Widen 25-Foot Channel Land Cut	65,742 cy Plus 3,852 cy Boulders
FY 1933	Placement of Stone Paving along Canal Banks	3,628 sf Stone
Dec 1933 – Dec 1935	Begin Construction of Bourne Bridge Piers & Abutments and Highway Approaches	Unknown
Dec 1933 – June 1935	Begin Construction of Sagamore Bridge Piers & Abutments and Highway Approaches	Unknown

Dec 1933 – Dec 1935	Begin Construction of Railroad Bridge Piers and Abutments	Unknown
FY 1934	Maintenance Dredging of 25-Foot Channel by US Dredge *Minquas*	384,047 cy
May 1934 – Aug 1934	Placement of Stone Paving along Canal Banks	3,000 Tons Stone
June 1934 – Dec 1934	Continue Improvement Dredging to Widen 25-Foot Channel Land Cut	1,002,044 cy Plus 5,408 cy Boulders
May 1934 – Oct 1935	Beginning Construction of the Approaches and Superstructures of the Bourne and Sagamore Highway Bridges	N/A
July 1934 – Aug 1934	Maintenance Dredging of 25-Foot Channel by US Dredge *Minquas* & *Marshall*	534,881 cy
Oct 1934 – April 1935	Removal of Boulders from the Easterly Approach Channel in Buzzards Bay by US Lighter	Unknown
Oct 1934 – June 1935	Install Lighting Systems on Highway Bridges	N/A
Nov 1934 – Dec 1935	Complete Construction of the Superstructure (Towers & Span) of the Railroad Bridge	NA
March 1935 – July 1935	Relocation of the Cape Shore Highway	N/A
April 1935	Improvement Dredging to Widen the 25-Foot Channel Cut through Buzzards Bay	111,381 cy
May 1935 – June 1935	Maintenance Dredging of 25-Foot Channel by US Dredge *Comstock*	303,125 cy
June 1935 – Sept 1935	Demolition of Old Highway Draw Bridges	N/A
June 1935 – Oct 1935	Improvement Dredging to Expand the 25-Foot East Mooring Basin	1,378,391 cy
July 1935 – June 1936	Maintenance Dredging of 25-Foot Channel by US Dredge *Minquas*	628,163 cy
Nov 1935 – March 1936	Improvement Dredging to Widen Channel Cut at Site of Old Bridge Piers and Removal of Old Piers	193,008 cy Plus 628 cy Boulders & 2,351 cy Old Concrete Piers

Dec 1935 – May 1936	Improvement Dredging to Widen the 25-Foot Channel Land Cut	1,202,359 cy Plus 5,238 cy Boulders
Nov 1935 – Dec 1936	Relocation of Southern Approach Railroad	NA
FY 1936 – FY 1937	Placement of Stone Paving along Canal Banks	Unknown
Jan 1936 – May 1936	Demolition of Old Railroad Draw Span	NA
Aug 1935 – Feb 1937	Improvement Dredging of 32-Foot Channel in Center Cut in Land Cut and Hog Island Channel Reaches with Disposal to Construct Stony Point Dike	8,359,936 cy 1,417 cy Boulders
July 1936	Removal of Remains of Old Concrete Highway Bridge Pier at Sagamore	Unknown
July 1936 – FY 1937	Improvement Dredging of 17-Foot Onset Bay Channel	Unknown
July 1936 – April 1937	Maintenance Dredging of 32-Foot Canal Land Cut in Reaches and Widths already Finished by U.S. Hopper Dredge *Minquas*	520,424 cy
Aug 1936 – Feb 1937	Construction of Steel Sheet Pile Bulkhead along South Bank at East End of Canal	????
July 1936 – May 1938	Maintenance and Improvement Dredging to Widen at 25 Feet and Deepen to 32 Feet in Canal Land Cut at East End	3,545,280 cy Plus 10,354 cy Boulders
July 1936 – Aug 1938	Continue Improvement Dredging of 32-Foot Canal Land Cut, Hog Island Channel Reaches, and West Mooring Basin, and Removal of Additional Old Bridge Piers	7,887,248 cy Plus 18,124 cy Boulders
Feb 1937 – Feb 1938	Improvement Dredging to Widen 32-Foot Cut at East and West Ends of the Canal Land Cut by U.S. Hopper Dredge *Marshall*	1,776,621 cy
Sept 1937 – Nov 1937	Excavation and Placement of Revetment, Drains, Culverts, Roads, etc	Unknown
July 1937 – May 1938	Maintenance Dredging of 32-Foot Canal Land Cut in Reaches and Widths already Finished by U.S. Hopper Dredge *Marshall*	286,136 cy

January 1938	Maintenance Dredging of 25-Foot East Mooring Basin	184,300 cy
Oct 1938 – March 1940	Repairs to Revetment on Canal Banks Damaged by Hurricane of Sept 1938	Unknown
Dec 1938 – June 1939	Maintenance Dredging of 32-Foot Canal Reaches and 15-Foot Onset Bay Channel	304,767 cy
Dec 1938 – June 1939	Maintenance Dredging of 15-Foot Onset Bay Channel	Unknown
June 1939 – Sept 1940	Construction of Revetment on Sandy Point Dike	Unknown
Aug 1938 – March 1939	Improvement Dredging of 32-Foot Canal Land Cut, 13-Foot East Boat Basin and 18-Foot West Boat Basin	570,892 cy Plus 3,342 cy Boulders
June 1938 – Oct 1938	Maintenance Dredging of 32-Foot Canal Reaches	425,019 cy
Sept 1938 – Dec 1938	Continue Improvement Dredging of 32-Foot Hog Island Channel Reach and 32-Foot West Mooring Basin	1,087,093 cy
Nov 1938 – June 1940	Continue Improvement Dredging of 32-Foot Canal Land Cut	3,392,163 cy Plus 22,033 cy Boulders
July 1939 – Jan 1941	Maintenance Dredging of 32-Foot Canal Reaches by U.S. Hopper Dredges *Atlantic*, *Minquas* & *Marshall*	3,583,784 cy
Oct 1939 – Nov 1939	Continue Improvement Dredging of 32-Foot Cleveland Ledge Channel Reach	Unknown
March 1940 – April 1940	Excavation and Placement of Revetment on Canal Banks on North Side and around the West Boat Basin	Unknown
May 1940 – June 1940	Improvement Dredging to Relocate Outer Alignment of 15-Foot Onset Bay Channel	21,492 cy Plus 129 cy Boulders
July 1940	Maintenance Dredging of 32-Foot Canal Reaches by U.S. Hopper Dredge *Minquas*	19,180 cy
July 1940 – May 1941	Removal of Boulders from the Land Cut & Cleveland Ledge Reach	2,298 cy Boulders

Aug 1940 – Oct 1940	Construction of Steel Mooring Dolphins at West Boat Basin	NA
Sept 1940 – Dec 1940	Construction of Riprap Slope Protection around the East Boat Basin	Unknown
Apr 1941 – May 1941	Planting Beach Grass on Stony Point Dike	NA
May 1941 – June 1941	Hydraulic Maintenance Dredging of the 25-Foot East Mooring Basin	192,509 cy
FY 1942	Blasting and Removal of Large Boulders from the 32-Foot Channel	946 cy Boulders
FY 1942	Maintenance of Riprap South Slope of Land Cut with Crushed Stone (Sta. 49 to 51)	Unknown
July 1941 – Aug 1941	Maintenance Dredging of the 32-Foot Hog Island Channel Reach by U.S. Hopper Dredge *Absecon*	57,750 cy
Feb 1942 – March 1943	Maintenance Dredging of the 32-Foot Channel, Approaches and Mooring Basins by U.S. Hopper Dredge *Atlantic*	1,623,737 cy
FY 1943	Continue Blasting and Removal of Large Boulders from the 32-Foot Channel	522 cy Boulders
July 1942 – FY 1943	Repairs to the Canal Slope Revetments, Eroded and as the Result of a Wreck in the Canal	Unknown
September 1942	Hydraulic Dredging to Place Material on Eroded Sections of Sandy Point Dike	Unknown
Nov 1942 – Jan 1943	Removal of Temporary Pier and Dolphins from Sandy Point Dike	NA
July 1943 – Oct 1943	Maintenance Dredging of the 32-Foot Canal Channel by U.S. Hopper Dredge *Marshall*	506,343 cy
FY 1944	Continue Blasting and Removal of Large Boulders from the 32-Foot Channel	278 cy Boulders
Sept 1943 – Nov 1943	Road Grading and Riprap Placement on Stony Point Dike	Unknown
January 1944	Maintenance Dredging of the 32-Foot Hog Island Channel by U.S. Hopper Dredge *Atlantic*	150,410 cy
Sept 1944 – Nov 1944	Improvement Dredging to Widen the 32-Foot Channel through the Hog Island Reach	170,780 cy Plus 779 cy Boulders

FY 1945	Continue Blasting and Removal of Large Boulders from the 32-Foot Channel	206 cy Boulders
April 1945 – May 1945	Maintenance Dredging of the 32-Foot Channel, Approaches and West Mooring Basin by U.S. Hopper Dredge *Atlantic*	549,349 cy
June 1945 – Aug 1945	Maintenance Dredging of the 25-Foot East Mooring Basin	93,041 cy
Sept 1945 – Oct 1945 Apr 1946 – May 1946	Maintenance Dredging of the 32-Foot Channel by U.S. Hopper Dredge *Atlantic*	295,076 cy
Oct 1945 – Dec 1945	Maintenance of Slopes of Land Cut with Crushed Stone and Gravel	30,950 cy Gravel Placed
May 1946 – Aug 1946	Depositing Gravel on Eroded Sections of the North and South Banks of the Canal	69,247 cy Gravel Placed
FY 1946	Continue Blasting and Removal of Large Boulders from the 32-Foot Channel	175 cy Boulders
May 1947 – June 1947	Maintenance Dredging of the 32-Foot Channel by U.S. Hopper Dredge *Atlantic*	182,679 cy
FY 1947	Continue Blasting and Removal of Large Boulders from the 32-Foot Channel	25 cy Boulders
October 1947	Maintenance Dredging of the 32-Foot Channel by U.S. Hopper Dredge *Atlantic*	64,466 cy
May 1948 – Aug 1948	Maintenance Dredging of the 32-Foot Channel by U.S. Hopper Dredge *Atlantic* and *Lyman*	847,690 cy
FY 1949	Emergency Agitation Dredging to Removal a Shoal from the 32-Foot Canal Channel	Unknown
June 1950 – Aug 1950	Maintenance Dredging of the 32-Foot Channel by U.S. Hopper Dredge *Lyman*	387,610 cy
May 1952	Raising of the Wreck of the *MS Arizona Sword* from the East End of the Canal Channel	Wreck Removal
Oct 1951 – Aug 1952	Maintenance Dredging of the 32-Foot Channel by U.S. Hopper Dredge *Lyman*	506,637 cy
April 1953 – May 1953	Maintenance Dredging of the 32-Foot Channel by U.S. Hopper Dredge *Goethals*	524,356 cy

Nov 1953 – July 1954	Maintenance Dredging of the Canal Land Cut, Hog Island Channel and Cleveland Ledge Channel by U.S. Hopper Dredge *Goethals*	600,610 cy
Nov 1954 – Dec 1954	Maintenance Dredging of the 32-Foot Channel by U.S. Hopper Dredge *Gerig*	315,800 cy
Nov 1955 – Dec 1955	Maintenance Dredging of the 32-Foot Channel in the Cleveland Ledge and Hog Island Reaches and the West Mooring Basin by U.S. Hopper Dredge *Comber*	186,284 cy
August 1956	Maintenance Dredging of the 32-Foot Channel by U.S. Hopper Dredge *Comber*	418,086 cy
April 1957	Maintenance Dredging of the 32-Foot Channel by U.S. Hopper Dredge *Comber*	165,042 cy
May 1957 – June 1957	Onset Bay - Improvement Dredging of the 15-Foot Channel, Turning Basin and Two 8-Foot Anchorage Areas	175,000 cy
April 1958	Maintenance Dredging of Shoals in the 32-Foot Canal Land Cut, Cleveland Ledge and Hog Island Reaches by U.S. Hopper Dredge *Comber*	266,970 cy
June 1958	Onset Bay – Removal of a Large Boulder from the 15-Foot Channel	One Boulder
May 1959	Maintenance Dredging of Shoals in the 32-Foot Canal Land Cut, Cleveland Ledge and Hog Island Reaches by U.S. Hopper Dredge *Goethals*	176,440 cy
May 1959 – June 1959	Onset Bay – Improvement - Removal Rock and Hard Material from the 15-Foot Channel and 8-Foot Anchorage	Unknown
May 1960	Maintenance Dredging of Shoals in the 32-Foot Canal Land Cut, Cleveland Ledge and Hog Island Reaches by U.S. Hopper Dredge *Comber*	99,150 cy
July 1960	Maintenance Dredging of the West Mooring Basin to –7 Feet	8,710 cy
Sept 1959 – Oct 1959	Blasting and Removal of Large Boulders and Hard Shoal Areas in the 32-Foot Canal	4,640 cy Hard Material and Boulders

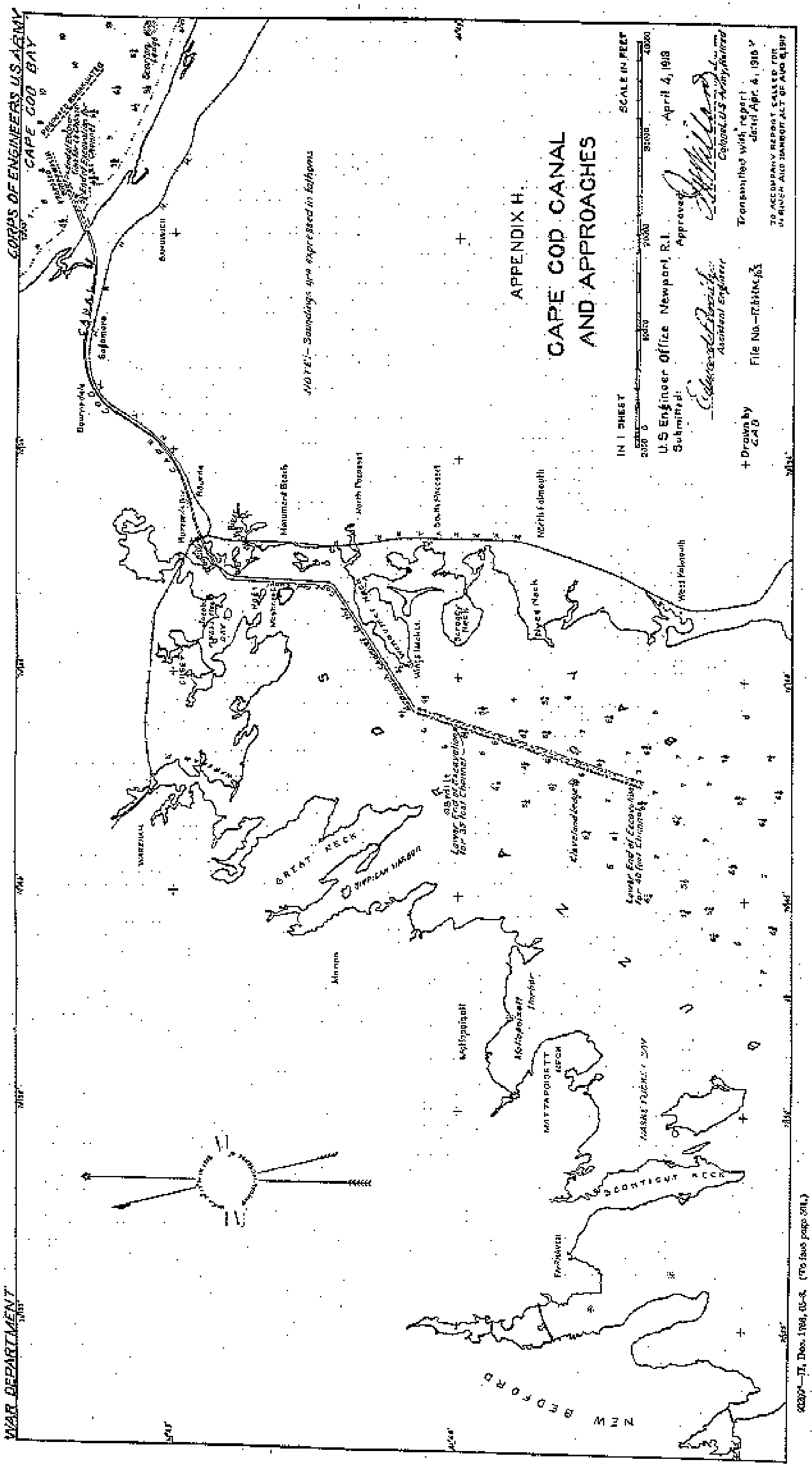
May 1961	Maintenance Dredging of Shoals in the 32-Foot Canal Land Cut, Cleveland Ledge and Hog Island Reaches by U.S. Hopper Dredge *Comber*	343,650 cy
March 1961 – Oct 1961	Improvement Dredging and Dry Excavation for Widening of the Hog Island Channel Reach along the SE Limit	260,786 cy
April 1961 – June 1961	Removal of Boulder Shoals from the Cleveland Ledge and Hog Island Channel Reaches	241 cy Boulders
May 1962 – June 1962	Maintenance Dredging of Shoals in the 32-Foot Canal Land Cut, Cleveland Ledge and Hog Island Reaches by U.S. Hopper Dredge *Comber*	297,897 cy
July 1962 – April 1963	Improvement Dredging to Expand the East Boat Basin by Adding the 8-Foot by 4.3-Acre Anchorage	192,000 cy
Sept 1962 – Oct 1963	Repairs to the North Jetty (Breakwater) at East Entrance to the Canal	27,700 Tons Stone
May 1963	Maintenance Dredging of Shoals in the 32-Foot Canal Land Cut, Cleveland Ledge and Hog Island Reaches by U.S. Hopper Dredge *Comber*	102,820 cy
March 1963 – April 1963	Blasting and Removal of Large Boulders from the Hog Island Channel Reach	65 cy Boulders Estimated
Feb 1964 – May 1964	Repairs to Riprap Slope Protection along Canal Land Cut Banks	6,000 Tons Stone Estimated
May 1964	Maintenance Dredging of the 32-Foot Canal Land Cut, Cleveland Ledge and Hog Island Reaches by U.S. Hopper Dredge *Goethals*	100,390 cy
May 1965 – June 1965	Maintenance Dredging of the 32-Foot Canal Land Cut, Cleveland Ledge and Hog Island Reaches by U.S. Hopper Dredge *Goethals*	137,900 cy
May 1965 – Jan 1966	Blasting and Removal of Large Boulders from the Cleveland Ledge Channel Reach	300 cy Boulders Estimated
May 1965 – May 1966	Repairs to Riprap Slope Protection along Canal Land Cut Banks	11,675 Tons Stone
April 1966 – May 1966	Maintenance Dredging of the 32-Foot Canal Land Cut, Cleveland Ledge and Hog Island Reaches by U.S. Hopper Dredge *Goethals*	84,500 cy

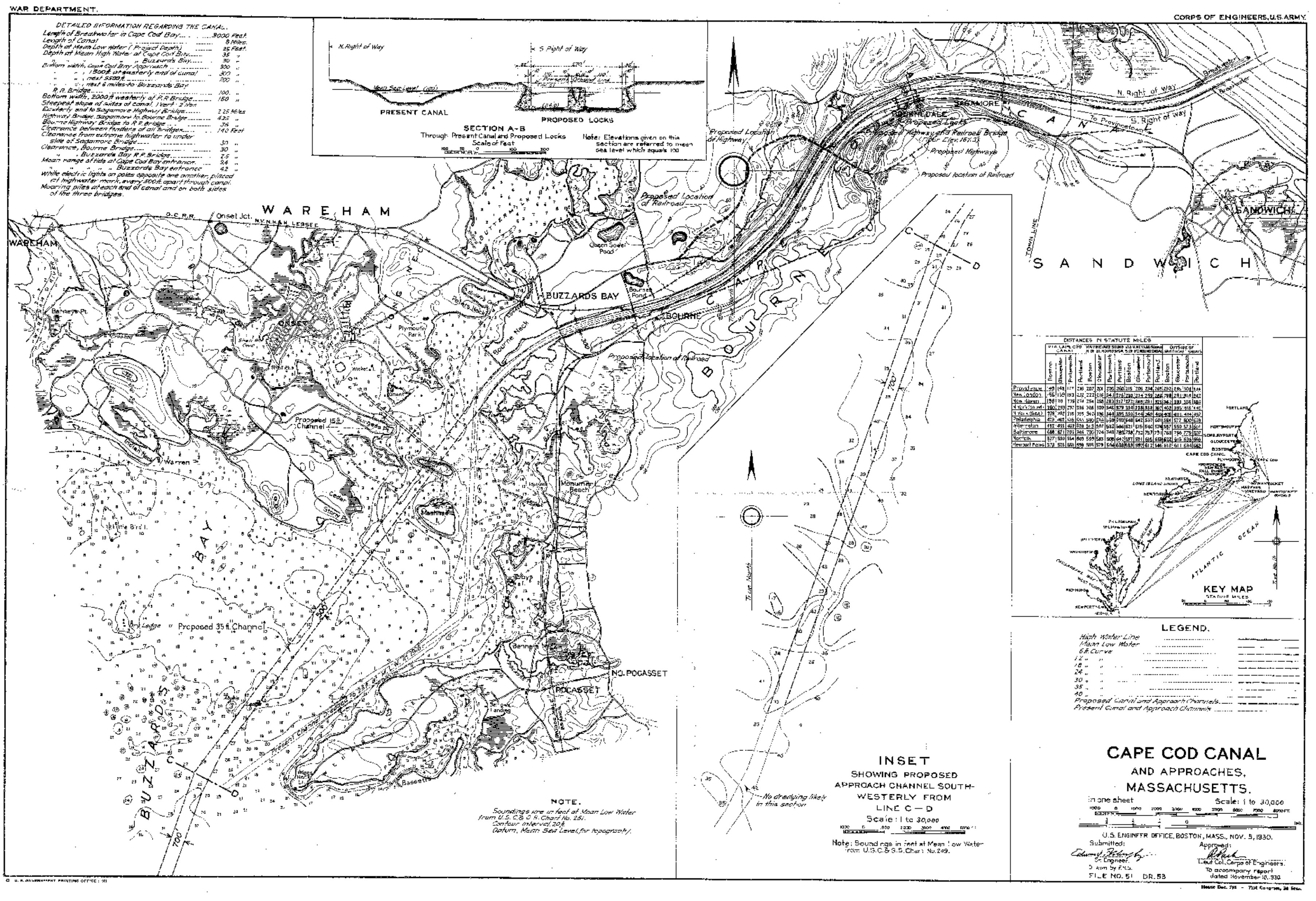
June 1967 – July 1967	Maintenance Dredging of Shoals in the 32-Foot Canal Land Cut, Cleveland Ledge and Hog Island Reaches by U.S. Hopper Dredge *Comber*	35,584 cy 25,135
March 1967 – June 1967	Repairs to Riprap Slope Protection along Canal Land Cut Banks	5,836 Tons Stone
June 1968	Maintenance Dredging of Shoals in the 32-Foot Canal Land Cut, Cleveland Ledge and Hog Island Reaches by U.S. Hopper Dredge *Comber*	136,000 cy
FY 1968 - May 1968	Repairs to Riprap Slope Protection along Canal Land Cut Banks	2,245 Tons Stone
FY 1969	Removal of Boulders from the Canal Channels	Unknown
March 1969 -	Repairs to the Steel Sheet-Pile Bulkhead at the East Boat Basin	NA
Nov 1969 – Feb 1970	Repairs to Riprap Slope Protection along Canal Land Cut Banks	Unknown
June 1970	Maintenance Dredging of Shoals in the 32-Foot Canal Land Cut, Cleveland Ledge and Hog Island Reaches by U.S. Hopper Dredge *Comber*	154,372 cy
FY 1972	Repairs to Riprap Slope Protection along Canal Land Cut Banks	Unknown
FY 1973	Installation of Steel Mooring Dolphins	Unknown
June 1973	Maintenance Dredging of Shoals in the 32-Foot Canal Channel	Unknown
July 1973 – Aug 1973	Maintenance Dredging of Shoals in the 32-Foot Canal Channel by U.S. Hopper Dredge	100,000 cy
FY 1974	Installation and Repair of Steel Mooring Dolphins at the East and West Mooring Basins, and Repairs to Riprap Slope Protection	Unknown
June 1975	Maintenance Dredging of Shoals in the 32-Foot Canal Channel by U.S. Hopper Dredge	125,620 cy
June 1975	Maintenance Dredging of the West Boat Basin	4,900 cy
FY 1975	Removal of a Sunken Vessel from the East Boat Basin	Wreck Removal
FY 1975	Rehabilitation of the South Jetty at the East Entrance to the Canal	15,500 Tons Stone, Est.

FY 1977	Maintenance Dredging of Shoals in the 32-Foot Canal Channel by U.S. Hopper Dredge	73,054 cy
FY 1980	Removal of a Boulder from the 32-Ft Channel	One Boulder
FY 1981	Removal of the Sunken Vessel *Mary J. Landry*	Wreck Removal
FY 1982	Replacement of Docks, Pilings and Dolphins in the West Boat Basin	Unknown
FY 1984	Installation of a New Electronic Traffic Control System, and Radar System	NA
FY 1985 – Sept 1986	Reconstruction of the Bulkhead along the Cape Shore on Either Side of the Entrance to the East Boat Basin with a Steel Sheet Pile Bulkhead with Associated Fendering System	Unknown
FY 1986	Purchase of Riprap Stone for Future Repairs to Canal Banks	Unknown
FY 1987	Maintenance Dredging of the 32-Foot Canal Channel by U.S. Hopper Dredge *McFarland*	177,000 cy
FY 1988 – March 1989	Repairs to Mooring Dolphins and Marine Railways at the West Boat Basin	NA
March 1990 - May 1990	Maintenance Dredging of the 32-Foot East Mooring Basin	121,952 cy
July 1992 – June 1993	Emergency Shoreline Protection at Wings Neck	Unknown
FY 1999 – FY 2000	Maintenance Dredging of the 32-Foot Canal Channel by Contract Hopper Dredge from Hog Island Reach Easterly, with Material used for CAD Cell Capping at Boston Harbor	162,200 cy
Sept 1999 – Oct 2000	Repairs to the South Jetty at the East Entrance to the Canal	Unknown
May 2000 – Aug 2002	Construction of Salt Marsh Restoration Project at Sagamore Marsh including Tidal Flow Culvert with Gates and Dike	NA
Sept 2000 – Feb 2002	Repairs to Docks and Mooring Dolphins	NA
April 2001 – FY03	Major Rehabilitation of the Buzzards Bay Railroad Bridge	NA

September 2002 – November 2002	Maintenance Dredging of the 32-Foot Channel in the Cleveland Ledge and Hog Island Reaches and Realignment of the Western Approach to Cleveland Ledge	117,000 cy plus 30 cy Boulders and 5 Minor Unquantified Shoals
FY 2008	Minor Repairs to the Canal Bank Revetment	NA
January 2010 – March 2010	Maintenance Dredging of the 32-Foot Channel and 25-Foot East Mooring Basin by Hopper Dredge with Material used to Cap CAD Cells in Boston Harbor. Contractor Over-dredged the Mooring Basin to 32 Feet at Own Expense to Yield Material for the Capping Project.	20,837 CY
Dec 2015 – June 2016	Maintenance Dredging of the East End of the 32-Foot Channel and East Mooring Basin with Placement on Town Neck Beach at Local Cost	118,029 cy

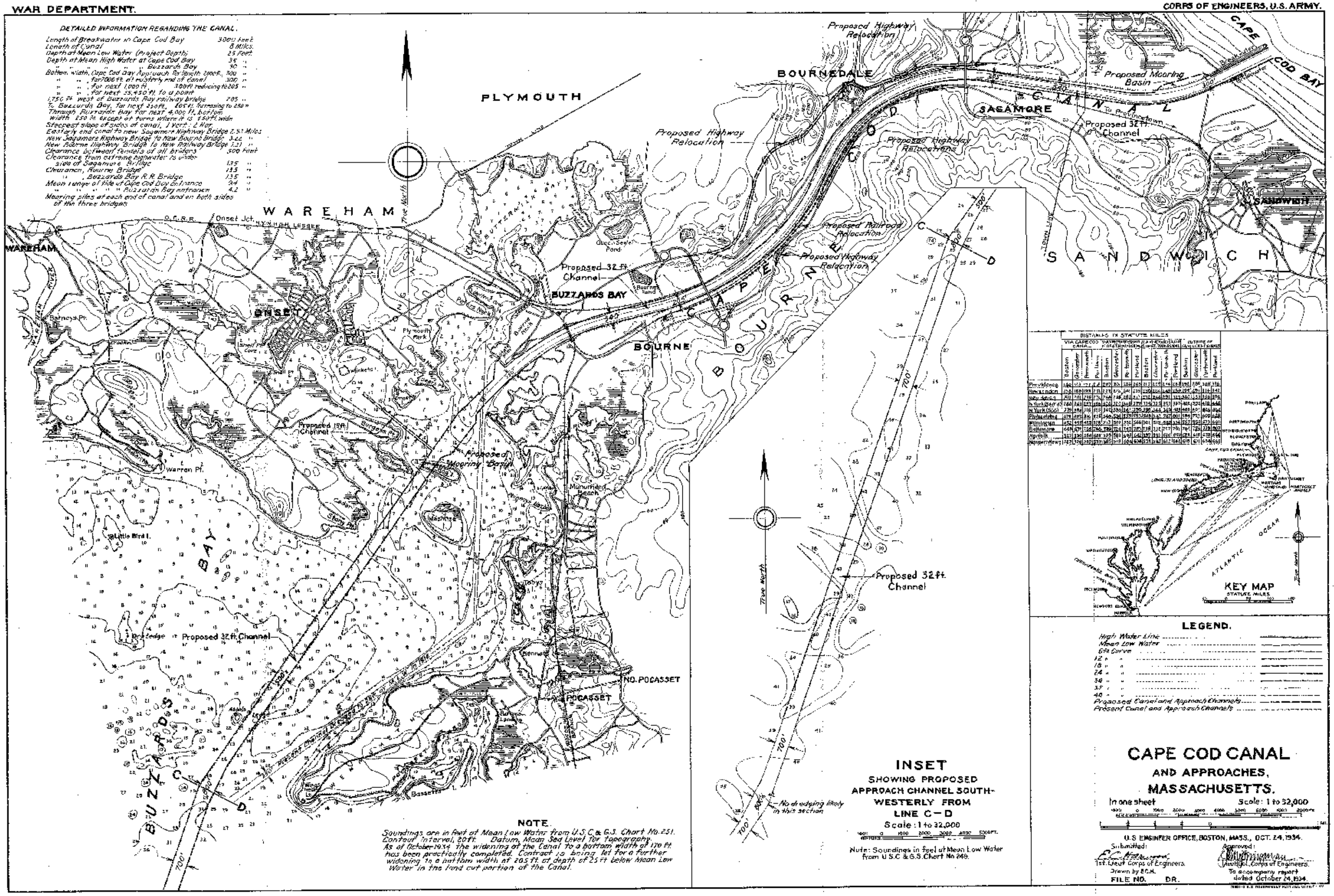
Project Maps from the 1919, 1930 and 1934 House Documents are provided below.


CORPS OF ENGINEERS U.S.ARMY
WAR DEPARTMENT
APPENDIX H.
CAPE COD CANAL
AND APPROACHES
IN 1 SHEET
SCALE IN FEET
2000 0 4000 8000 12000 16000 20000
U.S Engineer Office Newport, R.I. April 4, 1918
Submitted:
Assistant Engineer
Approved:
Colonel, U.S. Army, Retired
Transmitted with report dated Apr. 4, 1918
TO ACCOMPANY REPORT CALLED FOR IN RIVER AND HARBOR ACT OF AUG. 8, 1917
+ Drawn by C.A.D
File No.—R.&H.
CAPE COD BAY
CANAL
Sagamore
Bournedale
Sandwich
NOTE:- Soundings are expressed in fathoms
Monument Beach
North Pocasset
South Pocasset
North Falmouth
West Falmouth
Wareham
GREAT NECK
Marion
Mattapoisett
MATTAPOISETT NECK
SCONTICUT NECK
Fairhaven
NEW BEDFORD
Lower End of Excavation for 35 foot Channel
Lower End of Excavation for 40 foot Channel
Cleveland Ledge
82830°—H. Doc. 1198, 65-2. (To face page 80.)


WAR DEPARTMENT.
CORPS OF ENGINEERS, U.S. ARMY.
DETAILED INFORMATION REGARDING THE CANAL.
Length of Breakwater in Cape Cod Bay ... 3000 Feet.
Length of Canal ... 8 Miles.
Depth at Mean Low Water (Project Depth) ... 25 Feet.
Depth at Mean High Water at Cape Cod Bay ... 35 "
" " " " " Buzzards Bay ... 30 "
Bottom width, Cape Cod Bay Approach ... 300 "
" " , 1500 ft. at easterly end of canal ... 300 "
" " , next 5500 ft. ... 200 "
" " , next 6 miles to Buzzards Bay R.R. Bridge ... 100 "
Bottom width, 2000 ft westerly of R.R. Bridge ... 160 "
Steepest slope of sides of canal, 1 Vert. 2 Hor.
Easterly end to Sagamore Highway Bridge ... 2.25 Miles
Highway Bridge, Sagamore to Bourne Bridge ... 4.25 "
Bourne Highway Bridge to R.R. Bridge ... .75 "
Clearance between fenders of all bridges ... 140 Feet
Clearance from extreme highwater to under side of Sagamore Bridge ... 30 "
Clearance, Bourne Bridge ... 30 "
" , Buzzards Bay R.R. Bridge ... 7.5 "
Mean range of tide at Cape Cod Bay entrance ... 9.4 "
" " " " " Buzzards Bay entrance ... 4.2 "
White electric lights on poles opposite one another, placed at highwater mark, every 500 ft. apart through canal.
Mooring piles at each end of canal and on both sides of the three bridges.
N. Right of Way
S. Right of Way
Mean Sea Level
PRESENT CANAL
PROPOSED LOCKS
SECTION A-B
Through Present Canal and Proposed Locks
Scale of Feet
Note: Elevations given on this section are referred to mean sea level which equals 100
WAREHAM
O.C.R.R.
Onset Jct.
N.Y.N.H.&H. LESSEE
ONSET
Plymouth Park
BUZZARDS BAY
Queen Sewell Pond
Bourne Pond
BOURNE
Bourne Neck
Proposed Location of Railroad
Proposed Location of Highway
BOURNEDALE
SAGAMORE
Proposed Locks
Proposed Highway and Railroad Bridge
Proposed Highways
Proposed location of Railroad
N. Right of Way
S. Right of Way
To Provincetown
TOWN LINE
SANDWICH
CAPE COD CANAL
Proposed 15 ft. Channel
Warren
Little Bird I.
Bird I.
Proposed 35 ft. Channel
BUZZARDS BAY
Monument Beach
Tobys I.
NO. POCASSET
POCASSET
700'
NOTE.
Soundings are in feet at Mean Low Water from U.S.C.&G.S. Chart No. 251.
Contour interval 20 ft.
Datum, Mean Sea Level, for topography.
True North
No dredging likely in this section
INSET
SHOWING PROPOSED APPROACH CHANNEL SOUTH-WESTERLY FROM LINE C—D
Scale: 1 to 30,000
Note: Soundings in feet at Mean Low Water from U.S.C.&G.S. Chart No. 249.
DISTANCES IN STATUTE MILES
KEY MAP
STATUTE MILES
ATLANTIC OCEAN
PORTLAND
PORTSMOUTH
NEWBURYPORT
GLOUCESTER
BOSTON
CAPE COD CANAL
PLYMOUTH
PROVIDENCE
NEW BEDFORD
FALL RIVER
NEWPORT
NANTUCKET
NEW LONDON
NEW HAVEN
LONG ISLAND SOUND
NEW YORK
PHILADELPHIA
WILMINGTON
BALTIMORE
RICHMOND
NEWPORT NEWS
LEGEND.
High Water Line
Mean Low Water
6 ft. Curve
12 "
18 "
24 "
30 "
35 "
40 "
Proposed Canal and Approach Channels
Present Canal and Approach Channels
CAPE COD CANAL
AND APPROACHES,
MASSACHUSETTS.
In one sheet
Scale: 1 to 30,000
U.S. ENGINEER OFFICE, BOSTON, MASS., NOV. 5, 1930.
Submitted:
Edward J. Fitzgerald
Sr. Engineer.
Drawn by F.N.S.
FILE NO. 51 DR. 53
Approved:
Lieut. Col., Corps of Engineers.
To accompany report dated November 10, 1930
House Doc. 795 - 71st Congress, 3d Sess.

WAR DEPARTMENT.

CORPS OF ENGINEERS, U.S. ARMY.



DETAILED INFORMATION REGARDING THE CANAL.

Length of Breakwater in Cape Cod Bay	3000 Feet
Length of Canal	8 Miles.
Depth at Mean Low Water (Project Depth)	25 Feet.
Depth at Mean High Water at Cape Cod Bay	35 "
" " " " " " Buzzards Bay	30 "
Bottom width, Cape Cod Bay Approach for length 2000 ft.,	300 "
" " , for 700 ft. at easterly end of canal	300 "
" " , for next 1,000 ft. 300 ft. reducing to	205 "
" " , for next 35,450 ft. to a point 1,750 ft. west of Buzzards Bay railway bridge	205 "
To Buzzards Bay, for next 250 ft., 205 ft. increasing to	250 "
Through Buzzards Bay for next 4,000 ft., bottom width 250 ft. except at turns where it is 350 ft. wide	
Steepest slope of sides of canal, 1 Vert. : 2 Hor.	
Easterly end canal to new Sagamore Highway Bridge	2.53 Miles
New Sagamore Highway Bridge to New Bourne Bridge	3.22 "
New Bourne Highway Bridge to New Railway Bridge	1.21 "
Clearance between fenders of all bridges	500 Feet
Clearance from extreme high water to underside of Sagamore Bridge	135 "
Clearance, Bourne Bridge	135 "
" , Buzzards Bay R.R. Bridge	135 "
Mean range of tide at Cape Cod Bay entrance	9.4 "
" " " " " Buzzards Bay entrance	4.2 "
Mooring piles at each end of canal and on both sides of the three bridges	

NOTE.

Soundings are in feet at Mean Low Water from U.S.C.&G.S. Chart No. 251. Contour interval, 20 ft. Datum, Mean Sea Level for topography. As of October 1934 the widening of the Canal to a bottom width of 170 ft. has been practically completed. Contract is being let for a further widening to a bottom width of 205 ft. at depth of 25 ft. below Mean Low Water in the land cut portion of the Canal.

INSET

SHOWING PROPOSED APPROACH CHANNEL SOUTH-WESTERLY FROM LINE C–D

Scale: 1 to 32,000

Note: Soundings in feet at Mean Low Water from U.S.C.&G.S. Chart No. 249.

LEGEND.

- High Water Line
- Mean Low Water
- 6 ft. Curve
- 12 " "
- 18 " "
- 24 " "
- 30 " "
- 35 " "
- 40 " "
- Proposed Canal and Approach Channels
- Present Canal and Approach Channels

CAPE COD CANAL

AND APPROACHES, MASSACHUSETTS.

In one sheet

Scale: 1 to 32,000

U.S. ENGINEER OFFICE, BOSTON, MASS., OCT. 24, 1934.

Submitted:
1st. Lieut. Corps of Engineers.
Drawn by E.C.H.
FILE NO. DR.

Approved:
Lieut. Col., Corps of Engineers.
To accompany report dated October 24, 1934.

This Page Intentionally Left Blank

Bourne and Sagamore Bridges
Cape Cod Canal, Massachusetts
Major Rehabilitation Evaluation Report

Appendix C

Cost Engineering

March 2020

THIS PAGE LEFT INTENTIONALLY BLANK

Table of Contents

COST ENGINEERING 1
1.0 COST NARRATIVE 1
2.0 PROJECT DESCRIPTION 1
3.0 ALTERNATIVES 2
    3.1 ALTERNATIVES ELIMINATED FROM FURTHER CONSIDERATION 2
    3.2 ALTERNATIVES CONSIDERED FOR FURTHER EVALUATION 3
    3.3 BRIDGE REHABILITATION ALTERNATIVE 3
    3.4 BRIDGE REPLACEMENT ALTERNATIVE 4
4.0 ALTERNATIVES ROM CONSTRUCTION COST ESTIMATES 6
6.0 BASIS OF ESTIMATE 6
    6.1 ASSUMED CONSTRUCTION METHODOLOGY 6
    6.2 COST DATA SOURCES 7
    6.2 MAJOR ASSUMPTIONS 8
    6.3 MAJOR RISKS 8
7.0 SCHEDULE 9
8.0 CONTINGENCY 9
9.0 PLANNING, ENGINEERING, AND DESIGN (PED) 9
10.0 CONSTRUCTION MANAGEMENT (S&A) 10
11.0 CONDITIONAL COST CERTIFICATION AND TOTAL PROJECT COST SUMMARIES 10

List of Tables

Table C1: Rehabilitation Timeline 4
Table C2: Alternative ROM Cost Estimate Summary 6

List of Figures

Figure C1: Bridge Replacement Locations 5

THIS PAGE LEFT INTENTIONALLY BLANK

COST ENGINEERING

1.0 COST NARRATIVE

Corps of Engineers cost estimates for planning purposes are prepared in accordance with the following guidance:

- Engineer Technical Letter (ETL) 1110-2-573, Construction Cost Estimating Guide for Civil Works, 30 September 2008
- Engineer Regulation (ER) 1110-1-1300, Cost Engineering Policy and General Requirements, 26 March 1993
- ER 1110-2-1302, Civil Works Cost Engineering, 15 September 2008
- ER 1110-2-1150, Engineering and Design For Civil Works Projects, 31 August 1999
- ER 1105-2-100, Planning Guidance Notebook, 22 April 2000, as amended
- Engineer Manual (EM) 1110-2-1304 (Tables revised 30 March 2007), Civil Works Construction Cost Index System, 31 March 2013
- CECW-CP Memorandum For Distribution, Subject: Initiatives To Improve The Accuracy Of Total Project Costs In Civil Works Feasibility Studies Requiring Congressional Authorization, 19 Sep 2007
- CECW-CE Memorandum For Distribution, Subject: Application of Cost Risk Analysis Methods To Develop Contingencies For Civil Works Total Project Costs, 3 Jul 2007
- Cost and Schedule Risk Analysis Guidance, 17 May 2009

The goals of the Cost Engineering Section for the Major Rehabilitation Evaluation Report are to present a Total Project Cost (construction and non-construction costs) for the Bridge Rehabilitation Alternative and Bridge Replacement Alternative at the current price level to be used in determining the economically efficient rehabilitation strategy. In addition, the costing efforts are intended to produce a final product, or cost estimate, that is reliable and accurate and that supports the definition of the Government’s obligations. The cost estimates are screening level detail for the purposes of the decision to either rehabilitate or replace the bridges and are not intended, nor adequate, to be used for project budgeting.

2.0 PROJECT DESCRIPTION

The Major Rehabilitation Evaluation Study (MRES) will develop and prepare a Major Rehabilitation Evaluation Report (MRER) to develop the engineering requirements, costs, and associated consequences for rehabilitation of the Bourne and Sagamore bridges to determine the economically efficient rehabilitation strategy. The MRES will evaluate the existing condition and reliability of both the Bourne and Sagamore highway bridges of the Cape Cod Canal, MA Federal Navigation Project (FNP). The study will identify the timeline and budget requirements necessary to maintain satisfactory performance of the two bridges, and determine if restoration of the bridges can significantly improve their reliability and extend their physical life. Should the results of the evaluation demonstrate that rehabilitation was not a likely practicable long-term solution, then bridge replacement would need to be considered and alternative replacement plans developed. The MRES would thus include detailed analysis and evaluation of the alternatives for both rehabilitation and replacement, and a direction forward. The analysis will follow the guidance outlined in ER/EP 1130-2-500 and will result in a Major Rehabilitation Evaluation

Report (MRER). The MRER will look at all alternatives over a 50-year study period as determined by the ER/EP.

The major rehabilitation report compares the base condition against various maintenance scenarios. The base condition assumes that the existing O&M practices continue with emergency repairs of failed components as they occur, or “Fix-as-Fails” baseline. The rehabilitation alternative includes scheduled replacement of major bridge components to avoid emergency repair. The MRER will also include bridge replacement as an alternative for comparison.

3.0 ALTERNATIVES

A number of alternatives were initially considered during the early stages of the major rehabilitaton evaluation. These alternatives included: a program of repair and major rehabilitation for both bridges, replacement of one or both bridges with four lanes each, replacement of one or both bridges with four through-traffic lanes and two acceleration/deceleration lanes each, replacement of both bridges with a single bridge, construction of a new third highway bridge by others, replacement of one or both bridges with a tunnel(s), replacement of one or both bridges with low level draw spans or causeways, and finally deauthorization and closure of the canal. These initial alternatives were evaluated and screened to reduce the list to only those plans which in terms of likely cost, impacts on the marine and land transportation systems, traffic and environmental impacts, and overall practicability would be implementable.

3.1 ALTERNATIVES ELIMINATED FROM FURTHER CONSIDERATION

Several of the initial alternatives were eliminated from further consideration prior to requiring cost estimate development. The replacement of one or both bridges with a single bridge was screened out due to the need for extensive redesign of the local surface roads and regional highway connections on both the Cape and mainland sides of the Canal. This would require significant real estate takings includes lands from the Massachusetts Military Reservation as well as wetlands alternations and rerouting of utility corridors. The construction of a new third highway bridge by others was screened out due to the fact that USACE has no authority to construct a third highway bridge over the Canal and this alternative would not address the need to continue with repairs and ultimately rehabilitation or replacement of the existing bridge structures as they continue to age. The replacement of one or both bridges with low level draw spans was screened out as they would eliminate the Canal as a navigable channel for deep draft commercial vessels. This would also require construction and expansion of moorings and anchorage areas so the smaller vessels could queue for bridge openings which would also impact vehicular traffic. Similarly, the replacement of one or both bridges with low level causeways was screened out as it would eliminate the Canal as a navigable waterway for all but the smallest recreational craft. Both the low level draw spans and causeways would require most if not all cargo and military vessels and all commercial and military vessels, respectively, to return to the ocean route around the Cape, Islands, and shoals and banks when transitioning between northern New England and ports to the west and south. The alternative to deauthorize and close the canal was screened out as it would eliminate the Canal as a navigable waterway entirely and all navigation between northern New England and ports to the west and south would be required to return to the ocean route around the Cape, Islands, and shoals and banks to the east of Nantucket. While this route is more hazardous for all vessels, it is particularly dangerous for small craft which would pose significant life and safety issues.

A parametric cost was generated for the replacement of one or both bridges with a tunnel(s) alternative. Two recent tunnel projects were researched; the MLK Extension Midtown Tunnel project in Virginia is an immersed tube tunnel and the Parallel Thimble Shoal Tunnel project also in Virginia is a bored tunnel. The contract award cost was used to generate a unit price per linear foot which was escalated to then-current dollars using the most current CWCCIS rates at that time. It should be noted that the contract award cost for the MLK Extension project included other features of work in addition to the tunnel. A percentage of this total project cost was assumed to be related specifically to the tunnel. The unit price, regardless of tunnel construction type, was approximately $206,000/lf of two-lane tunnel. Assuming the length of tunnel necessary is similar to the current bridge lengths, and Canal tunnels would likely be four lane tunnels, a unit price of $412,000/lf was multiplied by 2,400 lf for the Sagamore tunnel and 4,050 lf for the Bourne tunnel resulting in costs of approximately $989M and $1,669M, respectively. This cost of the tunnels alone, along with the required road network reconfigurations and real estate concerns, proved to be cost prohibitive and the alternative was eliminated from further consideration.

A Level 5 screening /pre-budget estimate was generated for the replacement of one or both bridges with new bridges limited to four lanes each. This alternative was eliminated from further consideration, however, based on comments received during review of the draft report. While such a design is within the Corps existing authority to provide vehicular crossings over the Cape Cod Canal, a design that eliminates auxiliary lanes in this situation would not be consist with modern highway design under the FHWA design standards and MA DOT guidelines. Carrying this alternative forward for detailed consideration would therefore be contrary to best engineering practices and was not carried forward for detailed study in the final report.

3.2 ALTERNATIVES CONSIDERED FOR FURTHER EVALUATION

Two alternatives were carried forward for development and detailed evaluation. These include the major rehabilitation of both existing bridges followed by regular maintenance, repair and eventually another rehabilitation action within the 50-year period of analysis (herein referred to as the bridge rehabilitation alternative) and the bridge replacement for both bridges with 6 vehicle lanes (herein referred to as the bridge replacement alternative).

3.3 BRIDGE REHABILITATION ALTERNATIVE

This alternative consists of one major rehabilitation to each bridge; this rehab consists of truss span deck replacement, suspender cable replacement, abutment span replacement, bearing replacement, joint replacement, minor and major steel truss repairs, paving, and complete painting of structural steel members. Throughout the 50-year project life of the MRER, additional repairs to each bridge are expected to be necessary. This timeline of repairs is summarized in Table C1 below:

Table C1: Rehabilitation Timeline

Sagamore Bridge Rehabilitation Timeline	
Year	Repair
2025-2027	Major Rehabilitation
2032	Maintenance Painting
2033	Joint Replacement
2039	Maintenance Painting
2040	Paving and Joint Replacement
2045	Complete Painting
2047	Joint Replacement
2052	Maintenance Painting
2055	Paving and Joint Replacement
2059	Maintenance Painting
2065	Truss Deck Replacement, Floorbeam Repairs, Major Steel Repairs, Complete Painting, and Joint Replacement
Bourne Bridge Rehabilitation Timeline	
Year	Repair
2029-2031	Major Rehabilitation
2036	Maintenance Painting
2037	Joint Replacement
2043	Maintenance Painting
2044	Paving and Joint Replacement
2049	Complete Painting
2051	Joint Replacement
2056	Maintenance Painting
2059	Paving and Joint Replacement
2063	Maintenance Painting
2069	Truss Deck Replacement, Floorbeam Repairs, Major Steel Repairs, Complete Painting, Joint Replacement

Because of the existing and anticipated future conditions of the bridges, approximately 40 years after the initial major rehab of each bridge, another significant repair is expected. This repair consists of truss span deck replacement, floorbeam repairs, major steel repairs, joint replacement, and complete painting of structural steel of each bridge.

3.4 BRIDGE REPLACEMENT ALTERNATIVE

This alternative consists of the replacement of each bridge with a new cable-stayed -lane bridge with two on/off auxiliary lanes to assist motorists with acceleration and deceleration on and off the bridges to connect with local roads. Presently the right-hand travel lane in each direction doubles as the acceleration/deceleration lane which limits unrestricted through traffic flow to one lane in each direction. Adding dedicated acceleration/deceleration lanes to the bridge decks should further ease both through and entering/existing traffic. The replacement bridges would be constructed using the latest safety guidelines from MUTCD and FHWA as far as lane widths, shoulders, sidewalks, etc. For the purposes of this study, it is assumed that the new bridges would be located adjacent to and inshore of the existing bridges, as shown in Figure C1.

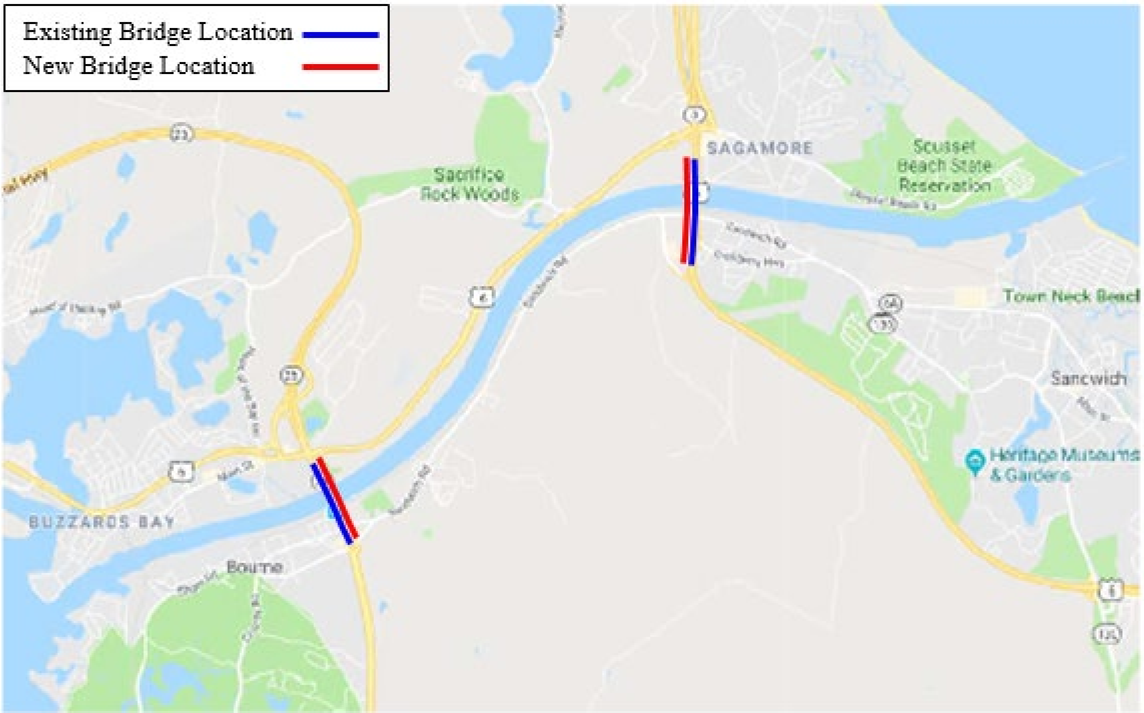


Figure C1: Bridge Replacement Locations

These new alignments of the bridges will necessitate significant alterations to the approaches and departures to and from each bridge. The replacement alternatives include demolition of the existing bridges upon completion of the replacements as well as major repair costs every 20 years over the 50-year study period. The major repair costs were assumed necessary and obtained from Philadelphia District and are based off the SR-1 Bridge which is also a cable-stayed bridge of similar length and lane configuration to those proposed in this project. Philadelphia District issued a contract for major repairs approximately 20 years after completion of their bridge. These repairs included cleaning the concrete surface, box girder repairs, drainage repairs, etc. It should be noted these major repair costs will vary in frequency and cost depending on the type of replacement bridge.

For the purposes of this study, a cable-stayed bridge was investigated. However, any bridge replacement would require further investigation to ascertain the most economical and favorable bridge type. These conceptual cable-stayed bridges are based on the SR-1 bridge over the Chesapeake and Delaware Canal in Delaware. This bridge type was chose for this study, in part, because it is a USACE-owned bridge over a marine navigation canal (the Chesapeake and Delaware Canal) of similar proportions to the Cape Cod Canal. It provides an alternative similar to what would be required for a new bridge to cross our Canal. A replacement bridge type and design have not been accomplished for this study. The bridge replacements described in the Structural Appendix are only representative of what could be used as a replacement structure.

4.0 ALTERNATIVES ROM CONSTRUCTION COST ESTIMATES

Rough Order of Magnitude (ROM) construction cost estimates for the two alternatives were developed using quantities provided by the Project Delivery Team (PDT), specifically the Corps of Engineers New England District (CENAE) Structural Engineering Design Section. These quantities were then applied to parametric unit costs that were based upon historical data such as bid abstracts for previously solicitated projects and previously developed construction cost estimates for similar repair work on the Sagamore and/or Bourne Bridges or used along with RSMeans, MII Cost Libraries, and vendor quotations to create new parametric construction cost estimates. The MCACES MII cost estimates are provided as Attachment 1 to this Cost Engineering Appendix. A Cost and Schedule Risk Analysis (CSRA) was performed for each alternative to identify and assess potential risks associated with this project. Table C2 summarizes these ROM costs, presented as the Project First Costs, along with the contingency for each alternative and each bridge developed in the CSRA.

Table C2: Alternative ROM Cost Estimate Summary

Project First Costs (FY20) – Sagamore Bridge				
	Construction $	Contingency %	Contingency $	Total
Rehabilitation Alternative	257,997,000	43%	110,939,000	368,936,000
Replacement Alternative	350,174,000	44%	151,722,000	501,895,000
Project First Costs (FY20) – Bourne Bridge				
	Construction $	Contingency %	Contingency $	Total
RehabilitationAlternative	284,778,000	43%	122,455,000	407,233,000
Replacement Alternative	508,360,000	44%	221,315,000	729,675,000

6.0 BASIS OF ESTIMATE

6.1 ASSUMED CONSTRUCTION METHODOLOGY

The assumed construction methodology for both the rehabilitation and replacement alternatives is largely via land-based plant(s). It is assumed there is significant marine traffic in the Canal that would prohibit a majority of the work be done via marine-based plant(s); however, a marine-based plant *was* included as support equipment for a one-year duration during both the rehabilitation and replacement construction at each bridge location. For the rehabilitation alternatives, there are partial and limited full lane closures on the bridges expected in each spring and fall construction season over the anticipated 3.25-year construction duration per bridge which will result in significant travel delays. There are no delays expected with the construction of the replacement bridges as the existing bridges will be in full operation over the 5-year construction duration per bridge. The bridge rehabilitations are expected to rely on truck-mounted cranes and scissor lifts for above-deck activities and snooper trucks and cable-suspended scaffolding for below-deck activities. The bridge replacements, if cable-stayed bridges are ultimately selected, are expected to be constructed using the span-by-span method with an over-head gantry. The superstructure is expected to be erected in one direction cantilever using large ~250 ton cranes.

6.2 COST DATA SOURCES

The construction cost estimates were developed using Micro-Computer Aided Cost Estimating System (MCACES), Second Generation (MII) using the appropriate Work Breakdown Structure (WBS). The rehabilitation construction cost is based on cost estimates for each of the individual ten repairs that make up the rehab. These cost estimates were developed utilizing cost resources such as RSMeans, MII Cost Libraries, and historical project costs and are supported by the preferred labor, equipment, materials, and crew/production breakdown. The replacement construction cost is based on bridge construction estimates for smaller projects scaled up to match the scope of this project. Specific features of work relative to the example cable-stayed bridge type were then added to the estimate. The unit cost for demolition of the existing bridges is based on a document from Florida Department of Transportation (FDOT) with bridge demolition costs from 2014. The document provides a range of demo costs, which were averaged, and an area cost factor applied from the latest PAX newsletter to bring the demo cost to current dollars more representive of the study area. The costs associated with the approaches to the new bridges are based on unit cost information provided by Massachusetts Department of Transportation (MASSDOT). The unit costs provided account for new roadway construction, embankment and drainage requirements, retaining walls, and any necessary fly-overs or bridges that might be necessary given the proposed approach layout and the existing roadway network. An additional cost was included in the approaches to account for site restoration, lighting, and beautification of the new roadways. The MASSDOT pricing appeared to be priced at FY17 price levels so these unit costs were also escalated to today’s dollars. The MII cost estimates are based on the 2016 Cost Book, 2016 Region 1 Equipment Book, and the latest prevailing wage information for Suffolk County available at the time the estimates were prepared; General Decision Number: MA20190008 05/17/2019 (for the rehabilitation alternative) and MA20200008 02/21/2020 (for the replacement alternative), Construction Type: Heavy (Heavy and Marine). A significant portion of the tasks associated with the rehabilitation estimates were derived from previous contract actions and bid abstracts, a record of historical repair costs maintained by NAE Structural Engineering Design Section, and previously completed cost estimates for repairs at the Sagamore and/or Bourne Bridges. All costs obtained from sources before FY19 were escalated to today’s dollars using EM 1110-2-1304, CIVIL WORKS CONSTRUCTION COST INDEX SYSTEMS (CWCCIS), dated 30 September 2020. Feature Code 08 (Roads, Railroads & Bridges) was used exclusively to determine those escalation factors. Quantities related to the individual cost estimates for each of the ten bridge repair tasks that comprise the bridge rehabilitation as well as the bridge replacement cost estimate were developed with minimal input from the PDT, except from the Structural Engineering Design Section, as no design work, even conceptual, has been completed for any of the alternatives. Both alternatives considered utility relocations for the existing utilities that run adjacent to the bridge abutments as well as along both the Sagamore and Bourne Bridges across and above the Canal. As part of either alternative, including rehabilitation, the gas lines would be removed from the bridges and new gas lines be constructed under the canal via directional drilling. There is assumed to be 1 line on each bridge that would require relocation. After speaking with several representatives from the directional drilling industry who have worked in the greater Boston area as well as the Cape, a lump sum price was assumed for each gas line to be drilled under the Canel It was assumed all other utilities on the bridges would be temporarily relocated to the bridge exteriors to accommodate construction. Under the replacement alternative, there are additional utilities that would require relocation; these costs were generated by assuming a total linear foot of pipe to be demo'ed and installed along with a and unit cost for each. There is also a gas metering station adjacent to the Bourne Bridge and a recitifier and anode bed adjacent to the Sagamore Bridge that would need to be demo'ed and constructed adjacent to the new abutments. The Real Estate Division has provided real estate cost estimates for the anticipated real estate actions in the bridge replacement alternative; these costs include both real estate damages and non-compenable damages. Lastly, the bridge replacement alternative includes an accounting of the potential environmental and cultural restoration and/or mitigation that will likely be required once the NEPA requirements are satisfied in the next phase of design. This cultural resource preservation cost has been estimated as 5% of the bridge replacement cost.

6.2 MAJOR ASSUMPTIONS

It was assumed the existing bridges would not be salvaged during construction. They are likely considered historical structures and will likely will be demo'ed and dismantled instead of demo'ed and salvaged.

It was also assumed the linear footage of new approach roads considered by MASSDOT in their conceptual cost estimate is appropriate given the proposed locations of the replacement bridges.

It was assumed the gas line relocation would run the same route on the mainland and Cape sides to the same point along the Canal where the line would be run under the canal regardless of the alternative selected. It was assumed each gas line would have it's own line directly drilled under the canal.

6.3 MAJOR RISKS

All risks associated with the project have been captured and quantified in the Cost and Schedule Risk Analysis to develop the risk-based contingency for each alternative. Overarching risks to the project as a whole, regardless of which alternative is selected, is certainly project funding related. The current project schedule has funding approval occurring in FY20; given the project first costs of either alterntive, this funding timeline seems unlikely at best.

More specific to the estimates themselves, the major risk of the rehabilitation estimate is that the scope of historical projects, and the cost associated with them, matches up with the assumed scope of the rehabilitation tasks. For those rehabilitation tasks we developed new cost estimates for, the risk is that we captured enough of the scope and quantity to develop a defensible estimate. The major risk of the replacement estimate is that our previous bridge estimates for much smaller bridges are scalable in any way to capture the anticipated cost of new cable-stayed bridges and the additional features of work that were added are adequate, in quantity and unit price, to fully capture the anticipated cost of those features.

7.0 SCHEDULE

The construction schedule for both the rehabilitation and replacement alternatives were prepared using Microsoft Excel and are based on years of anticipated work. There are too few details on any individual repair, the major rehab, or the replacement to drill too far into features of work and sub features to be able to generate a more comprehensive schedule. It should be noted that the real estate activities for the replacement are not accounted for in the construction schedule but are expected to take considerable time to complete. The project start for both rehabilitation and replacement are based on input from CENAE Structural Engineering Design Section and their assessment of the current condition of the bridges. The repair or replacement must commence by 2025 in order to avoid having to contract all or part of the initial major rehabilitation to avoid posting load limits on one or both of the bridges. The project schedule is provided as Attachment 2 to this Cost Engineering Appendix.

8.0 CONTINGENCY

The goal in contingency development is to identify the uncertainties associated with an item of work or task, forecast the cost/risk relationship, and assign a value to this task that would limit the cost risk to an acceptable degree of confidence. Consideration must be given to the details available at each stage of planning, design, or construction for which a cost estimate is being prepared.

A Cost and Schedule Risk Analysis (CSRA) was conducted according to the procedures outlined in the manual entitled “Cost and Schedule Risk Analysis Guidance”, dated 17 May 2009. Members of the New England District Project Delivery Team (PDT) participated in a cost risk analysis brainstorming session to identify risks associated with the project. The Risk Analysis utilized the “HIGH RISK” category as both alternatives represent complex projects involving construction with life safety issues. Assumptions were made to the likelihood and impact of each risk item, as well as the probability of occurrence and magnitude of the impact if it were to occur. Adjustments were made to the analysis upon review by the PDT and the final contingencies were established. The CSRA Report is provided as Attachment 3 to this Cost Engineering Appendix.

It should be noted that the subject matter experts applied uncertainty bounds to the deterministic cost estimate in order to characterize overall project uncertainty. There was no uncertainty evaluation at the detailed cost estimate level.

9.0 PLANNING, ENGINEERING, AND DESIGN (PED)

The costs were estimated for all activities associated with the planning, engineering and design effort. The planning, engineering and design of the rehabilitation and subsequent repairs is expected to occur in-house while the replacement is expected to be contracted to an architect/engineer firm. The PED costs for all portions of the rehabilitation and replacement alternatives were estimated using a percentage of the construction cost which varies based on the value of the construction. For the rehabilitation alternative, if the construction cost is less than \$1M, PED is calculated as 20% of the construction cost, if the construction cost is greater than \$1M but less than \$2M, PED is calculated as 15% of the construction cost, if the construction cost, if the construction cost is greater than \$2M but less than \$5M, PED is calculated as 10% of the construction cost, and if the contruction cost is greater than $5M, PED is calculated as 5% of the construction cost. For the replacement alternative, the PED for the bridge replacement was calculated as 8% of the bridge replacement cost and PED for the approach roadway construction was calculated as 10% of the approach roadway construction cost. It is expected the PED values generated include the preparation of Design Documentation Reports and plans and specifications for each construction contract and engineering support during construction through project completion. It includes all the in-house labor based upon work-hour requirements, material and facility costs, travel and overhead.

10.0 CONSTRUCTION MANAGEMENT (S&A)

The costs were developed for all construction management activities from pre-award requirements through final contract closeout. These costs include the in-house labor based upon work-hour requirements, materials, facility costs, support contracts, travel and overhead. Costs were developed based on the input from the Construction Division in accordance with the CWBS and include but are not limited to anticipated items such as the salaries of the resident engineer and staff, survey men, inspectors, draftsmen, clerical, and custodial personnel; operation, maintenance and fixed charges for transportation and for other field equipment; field supplies; construction management, general construction supervision; project office administration, distributive cost of area office and general overhead charged to the project. The work items and activities would include, but not be limited to: the salaries of all supervisory, engineering (including resident geologist and geological staff), office and safety field personnel; all on site expenses.

11.0 CONDITIONAL COST CERTIFICATION AND TOTAL PROJECT COST SUMMARIES

Conditional Cost Certification was obtained from the Walla Walla District Cost Engineering Mandatory Center of Expertise on 02 March 2020. The areas of concerns resulting in a conditional certification are as follows:

- Costs have been developed to a Class 5 screening/pre-budget development level sufficient for MRER evaluation of rehabilitation versus replacement but not to the Class 3 level required for Feasibility Phase Certification/budget authorization.
- Additional design refinement and NEPA documentation will be required prior to establishment of budget/funding.
- MRER has not been developed to a Feasibility Level Scope and should not be used for budgetary/funding purposes.

The Total Project Cost Summary (TPCS) addresses the inflation through project completion; accomplished by escalation to the mid-point of construction. The TPCS includes costs for all construction features of the project, PED and S&A, along with the appropriate contingencies and escalation associated with each of these activities. The TPCS is formatted according to the CWWBS. The TPCS was prepared using the MCACES/MII cost estimate, contingencies developed through the CSRA, the construction schedule, and estimates of PED and S&A based on percentages of the construction cost and input from the Construction Division, respectively. The TPCS for both the bridge rehabilitation and bridge replacement alternatives for the Bourne and Sagamore Bridges are provided as Attachment 4 to this Cost Engineering Appendix.

Attachment 1

MCACES MII Cost Estimates

Description	DirectLabor	DirectEQ	DirectMatl	DirectSubBid	DirectCost	ContractCost	ProjectCost
Project Cost Summary Report	**8,876,316**	**2,045,776**	**3,459,188**	**55,246,992**	**69,628,272**	**107,392,905**	**107,392,905**
Sagamore Bridge Major Rehab	**8,876,316**	**2,045,776**	**3,459,188**	**55,246,992**	**69,628,272**	**107,392,905**	**107,392,905**
0001 Truss Span Deck Replacement	**0**	**0**	**0**	**12,962,692**	**12,962,692**	**19,514,751**	**19,514,751**
0002 Suspender Cable Replacement	**0**	**0**	**0**	**7,102,467**	**7,102,467**	**10,692,445**	**10,692,445**
0003 Replace Abutment Spans	**1,156,076**	**61,048**	**2,359,542**	**947,672**	**4,524,339**	**8,192,055**	**8,192,055**
0004 Bearing Replacement	**489,900**	**90,041**	**47,473**	**0**	**627,414**	**1,167,418**	**1,167,418**
0005 Joint Replacement	**0**	**0**	**0**	**1,064,050**	**1,064,050**	**1,979,859**	**1,979,859**
0006 Minor Steel Truss Repairs	**1,403,784**	**428,190**	**233,251**	**1,263,858**	**3,329,082**	**6,194,363**	**6,194,363**
0007 Major Steel Truss Repairs	**5,826,556**	**1,466,497**	**818,923**	**2,667,326**	**10,779,301**	**20,056,854**	**20,056,854**
0008 Paving	**0**	**0**	**0**	**1,555,184**	**1,555,184**	**2,341,260**	**2,341,260**
0009 Maintenance Painting of Structural Steel	**0**	**0**	**0**	**4,697,846**	**4,697,846**	**7,072,396**	**7,072,396**
0010 Complete Painting of Structural Steel	**0**	**0**	**0**	**14,235,897**	**14,235,897**	**21,431,504**	**21,431,504**
02 Relocations (Utilities)	**0**	**0**	**0**	**8,750,000**	**8,750,000**	**8,750,000**	**8,750,000**

Description	DirectLabor	DirectEQ	DirectMatl	DirectSubBid	DirectCost	ContractCost	ProjectCost
Project Cost Summary Report	**14,573,133**	**3,334,088**	**4,533,515**	**60,767,376**	**83,208,112**	**125,474,766**	**125,474,766**
Bourne Bridge Major Rehab	**14,573,133**	**3,334,088**	**4,533,515**	**60,767,376**	**83,208,112**	**125,474,766**	**125,474,766**
0001 Truss Span Deck Replacement	**0**	**0**	**0**	**20,932,830**	**20,932,830**	**30,163,295**	**30,163,295**
0002 Suspender Cable Replacement	**0**	**0**	**0**	**7,102,467**	**7,102,467**	**10,234,345**	**10,234,345**
0003 Replace Abutment Spans	**1,156,076**	**61,048**	**2,359,542**	**947,672**	**4,524,339**	**7,841,080**	**7,841,080**
0004 Bearing Replacement	**1,530,180**	**270,124**	**142,418**	**0**	**1,942,722**	**3,459,918**	**3,459,918**
0005 Joint Replacement	**0**	**0**	**0**	**1,087,900**	**1,087,900**	**1,937,511**	**1,937,511**
0006 Minor Steel Truss Repairs	**2,609,909**	**604,965**	**689,625**	**1,255,726**	**5,160,225**	**9,190,177**	**9,190,177**
0007 Major Steel Truss Repairs	**9,276,968**	**2,397,951**	**1,341,930**	**2,651,062**	**15,667,910**	**27,903,991**	**27,903,991**
0008 Paving	**0**	**0**	**0**	**2,237,912**	**2,237,912**	**3,224,734**	**3,224,734**
0009 Maintenance Painting of Structural Steel	**0**	**0**	**0**	**3,920,749**	**3,920,749**	**5,649,628**	**5,649,628**
0010 Complete Painting of Structural Steel	**0**	**0**	**0**	**11,881,058**	**11,881,058**	**17,120,086**	**17,120,086**
02 Relocations (Utilities)	**0**	**0**	**0**	**8,750,000**	**8,750,000**	**8,750,000**	**8,750,000**

Description	DirectLabor	DirectEQ	DirectMatl	DirectSubBid	DirectCost	ContractCost	ProjectCost
Project Cost Summary Report	**220,578,467**	**50,312,618**	**91,232,524**	**237,287,701**	**599,411,310**	**775,621,341**	**775,621,341**
CCC Sagamore Bridge Replacement (4 Lanes with Auxiliary On/Off Lanes)	**84,003,935**	**22,488,935**	**33,512,051**	**107,709,979**	**247,714,899**	**316,468,901**	**316,468,901**
01 Lands and Damages (Real Estate)	**0**	**0**	**0**	**6,925,000**	**6,925,000**	**6,925,000**	**6,925,000**
02 Relocations (Utilities)	**0**	**0**	**0**	**20,500,000**	**20,500,000**	**20,500,000**	**20,500,000**
08 Replace Sagamore Bridge	**84,003,935**	**22,488,935**	**33,512,051**	**23,871,520**	**163,876,440**	**232,630,442**	**232,630,442**
08 Bridge Approaches (MASSDOT)	**0**	**0**	**0**	**34,603,464**	**34,603,464**	**34,603,464**	**34,603,464**
18 Cultural Resource Preservation	**0**	**0**	**0**	**13,361,695**	**13,361,695**	**13,361,695**	**13,361,695**
08 Major Bridge Repairs (20 years out)	**0**	**0**	**0**	**4,224,150**	**4,224,150**	**4,224,150**	**4,224,150**
08 Major Bridge Repairs (40 years out)	**0**	**0**	**0**	**4,224,150**	**4,224,150**	**4,224,150**	**4,224,150**
CCC Bourne Bridge Replacement (4 Lanes with Auxiliary On/Off Lanes)	**136,574,533**	**27,823,684**	**57,720,472**	**129,577,723**	**351,696,411**	**459,152,440**	**459,152,440**
01 Lands and Damages (Real Estate)	**0**	**0**	**0**	**6,950,000**	**6,950,000**	**6,950,000**	**6,950,000**
02 Relocations (Utilities)	**0**	**0**	**0**	**18,500,000**	**18,500,000**	**18,500,000**	**18,500,000**
08 Replace Bourne Bridge	**136,574,533**	**27,823,684**	**57,720,472**	**25,902,976**	**248,021,664**	**355,477,693**	**355,477,693**
08 Bridge Approaches (MASSDOT)	**0**	**0**	**0**	**53,549,250**	**53,549,250**	**53,549,250**	**53,549,250**
18 Cultural Resource Preservation	**0**	**0**	**0**	**20,451,347**	**20,451,347**	**20,451,347**	**20,451,347**
08 Major Bridge Repairs (20 years out)	**0**	**0**	**0**	**4,224,150**	**4,224,150**	**4,224,150**	**4,224,150**

Attachment 2

Construction Schedule

Fiscal Year	EXISTING SAGAMORE BRIDGE		EXISTING BOURNE BRIDGE		SAGAMORE REPLACEMENT	BOURNE REPLACEMENT	Fiscal Year
	No.	Work Item	No.	Work Item	Work Item	Work Item	
2023							2023
2024							2024
2025	01	**SAGAMORE MAJOR REHAB**			**SAGAMORE REPLACEMENT** **BRIDGE APPROACHES**		2025
2026							2026
2027							2027
2028							2028
2029			01	**BOURNE MAJOR REHAB**			2029
2030						**BOURNE REPLACEMENT** **BRIDGE APPROACHES**	2030
2031							2031
2032	02	Maintenance Painting					2032
2033	03	Joint Replacement					2033
2034							2034
2035							2035
2036			02	Maintenance Painting			2036
2037			03	Joint Replacement			2037
2038							2038
2039	04	Maintenance Painting					2039
2040	05	Paving Joint Replacement					2040
2041							2041
2042							2042
2043			04	Maintenance Painting			2043
2044			05	Paving Joint Replacement			2044
2045	06	Complete Painting					2045
2046							2046
2047	07	Joint Replacement					2047
2048							2048
2049			06	Complete Painting	Major Repairs		2049
2050							2050
2051			07	Joint Replacement			2051
2052	08	Maintenance Painting					2052
2053							2053
2054						Major Repairs	2054
2055	09	Paving Joint Replacement					2055
2056			08	Maintenance Painting			2056
2057							2057
2058							2058
2059	10	Maintenance Painting	09	Paving Joint Replacement			2059
2060							2060
2061							2061
2062							2062
2063			10	Maintenance Painting			2063
2064							2064
2065	11	Truss Deck Replacement Floorbeam Repair Major Steel Repairs Complete Painting Joint Replacement					2065
2066							2066
2067							2067
2068							2068
2069			11	Truss Deck Replacement Floorbeam Repair Major Steel Repairs Complete Painting Joint Replacement	Major Repairs		2069

Attachment 3

Cost and Schedule Risk Assessment

US Army Corps
of Engineers®

Major Rehabilitation Evaluation Report

Cape Cod Canal, Bourne & Sandwich, Massachusetts

Cost and Schedule Risk Analysis Report for the Feasibility Report

Prepared for:
U.S. Army Corps of Engineers,
New England District

Prepared by:
U.S. Army Corps of Engineers,
New England District

Date: 05 March 2020

TABLE OF CONTENTS

EXECUTIVE SUMMARY 1
Project Purpose 1
Project Scope 1
Risk Analysis Results 1
BRIDGE REHABILITATION 3
Key Risk Items, Cost 3
Key Risk Items, Schedule 3
BRIDGE REPLACEMENT 4
Key Risk Items, Cost 4
Key Risk Items, Schedule 4
Total Project Cost Summary 5
BRIDGE REHABILITATION – BOURNE BRIDGE 6
BRIDGE REHABILITATION – SAGAMORE BRIDGE 6
BRIDGE REPLACEMENT – BOURNE BRIDGE 6
BRIDGE REPLACEMENT – SAGAMORE BRIDGE 7
PURPOSE/BACKGROUND 8
REPORT SCOPE 8
Project Scope 8
USACE Risk Analysis Process 9
METHODOLOGY/PROCESS 10
Identify and Assess Risk Factors 11
Quantify Risk Factor Impacts 11
Analyze Cost Estimate and Schedule Contingency 12
KEY CONSIDERATIONS AND ASSUMPTIONS 13
RISK ANALYSIS RESULTS 14
Risk Register 14

Cost Risk Analysis - Cost Contingency Results 16
Key Risk Items, Cost 17
Schedule Risk Analysis - Schedule Contingency Results 22
Key Risk Items, Schedule 23

LIST OF TABLES

Table 1 - Risk Analysis Results 1
Table 2 - Cost Summary 6
Table 3 - PDT Risk Identification Team 10
Table 4 - Work Breakdown Structure by Feature 11
Table 5 - Risk Register (High Risk Level) 15
Table 6 - Cost Contingency Analysis at Various Confidence Levels 19
Table 7 - Cost Contingency Analysis at Various Confidence Levels 25

LIST OF FIGURES

Figure 1 - Cost Risk Sensitivity Analysis 16

ATTACHMENTS

ATTACHMENT 1	Detailed Risk Registers

EXECUTIVE SUMMARY

Project Purpose

The purpose of the Major Rehabilitation Evaluation Study is to evaluate the existing conditions and reliability of both the Bourne and Sagamore highway bridges of the Cape Cod Canal, MA Federal Navigation Project (FNP). The study has identified the timeline and budget requirements necessary to maintain satisfactory performance of the two bridges. The Study has included a detailed analysis and evaluation of the alternatives for both rehabilitation and replacement as well as a direction forward. This Study has resulted in a Major Rehabilitation Evaluation Report. The rehabilitation alternative includes scheduled replacement of major bridge components to avoid emergency repair. The Report also includes bridge replacement as an alternative for comparison.

Project Scope

The study area consists of the Bourne and Sagamore highway bridges as well as the bridge approaches. These bridges are the primary access points to Cape Cod and the Islands from mainland Massachusetts.

Risk Analysis Results

A Cost and Schedule Risk Analysis (CSRA) was performed in April 2017 on this project to identify the 90% confidence level contingencies for the anticipated construction activities. The contingencies considered both cost and schedule risk. The risk analysis analyzed the construction costs only; the subsequent contingency will be applied to the Planning, Engineering & Design (PED) and Supervision & Administration (S&A). Because the Risk Events are nearly identical for either rehabilitation or replacement of the Bourne and Sagamore Bridges, for the purposes of the risk analyses the bridges were combined in each of the analysis spreadsheets. The following results were observed:

Table 1 - Risk Analysis Results

	Contingency Amount	**Contingency %**
BRIDGE REHABILITATION 1)		
Project Construction	$204,261,948	43%
Project Schedule	68 Months	94%
BRIDGE REPLACEMENT 1)		
Project Construction	$329,592,512	44%
Project Schedule	71 Months	59%

1) The CSRA for each alternative includes both the Bourne Bridge and the Sagamore Bridge.

It should be noted that typically the 80% confidence level contingency is reported. This is the confidence level required by ER 1110-2-1302 (CIVIL WORKS COST ENGINEERING). Because of the lack of design in both the rehab and replacement alternatives as well as the regional impact of the project, NAE Cost Engineering Section feels the 90% confidence level contingency is more appropriate at this time.

BRIDGE REHABILITATION

Key Risk Items, Cost

The following were high risk items affecting cost for the bridge rehabilitation alternative (the complete risk register can be viewed in Appendix A):

- ES12 – Cost Estimate

  Discussion: The level of design is pre-conceptual at this point. Items included in the major rehab have been generated by the Structural Engineering Design Section based on their Structural Reliability Analysis. The cost estimate has been put together in MII using unit prices from Mass DOT as well as other smaller bridge projects from NAE. Several items are estimated using parametric cost data from historical projects. It is very likely the current cost estimate has omitted items, underestimated the quantity, or underestimated the cost. The impacts have the potential to be significant.

  Risk Reduction Measures: Build and refine cost estimate as soon as details are flushed out regarding the design. Contacting other USACE districts and possibly the MCX to check on recent estimates built for this type of bridge construction. Reaching out to industry to discuss all facets of the project, in a generic manner of course, could also shed some light on the cost estimate and how it has been prepared to allow for revisions that could reduce the risk.

- TD18 – Current Design Status

  Discussion: Current cost is based on unit price data and programmatic costs from other projects; this data may not be scalable to a project this size.

  Risk Reduction Measures: Additional review of those historical costs will be beneficial to flush out and refine the cost estimate for this rehab alternative. As each piece of the rehab is actually designed the estimate can be refined.

Key Risk Items, Schedule

The following items were high risk items affecting the project schedule for the bridge rehabilitation alternative.

- ES13 – Schedule

  Discussion: The current schedule developed for the project includes only an estimate total duration. It is very likely once a more detailed schedule is developed for the project that there will be significant impacts once all major items have been accounted for.

  Risk Reduction Measures: Build and refine the schedule as soon as details are flushed out regarding the design. Contacting other USACE districts and possibly the MCX to check on recent schedules built for this type of bridge construction. Reaching out to industry to discuss all facets of the project, in a generic manner of course, could also shed some light on the schedule and how it has been prepared to allow for revisions that could reduce the risk.

- EX22 – Adequacy of Project Funds

Discussion: A delay in receiving projects funds would result in schedule delays. This risk is similar to Risk 16 regarding availability of State funding. This likelihood is possible, as this project may not be a national priority which may result in a delay due to funding.

Risk Reduction Measures: Communication with the vertical team will help to finalize a plan going forward on how this project might be funded. A realistic plan and timeline should be established prior to any funding request to ensure the proper escalation is applied.

BRIDGE REPLACEMENT

Key Risk Items, Cost

The following were high risk items affecting cost for the bridge replacement alternative.

- TD24 – Bridge Design/Type

  Discussion: The Major Rehabilitation Evaluation Report (MRER) is currently considering a cable-stayed bridge as an alternative to rehabilitation. The cable-stayed bridge is one of the higher-cost bridge replacement alternatives. The design *will* be limited by some construction budget at the time of design. It is possible something other than cable-stayed will be design/constructed, however the cost impact will be marginal based on the allowable budget.

  Risk Reduction Measures: Coordination with the A/E in regards to bridge type and what will be designed and ultimately constructed will be helpful in mitigating this risk. A planning document will need to be completed for the replacement project and a budget established in that document which will help to tie the hands of the A/E to design within a certain budget.

- EX32 – Bidding climate

  Discussion: The size and potential value of this project will likely draw any and all qualified contractors to the table. It is unlikely this would be an issue but could have moderate impact on project cost if the competition is not there during the selection process.

  Risk Reduction Measures: Market research will help to mitigate this risk to see how much competition there might be around the time of solicitation.

- CA3 – Contract Modifications

  Discussion: Due to the project size and complexity, the PDT is certain there will be contract mods during construction; such as differing site conditions for foundation issues or utility issues. Depending on what the modification is for, the impact to cost and schedule could be significant.

  Risk Reduction Measures: The easier way to reduce contract modifications is to make the design documents as clear and understandable as possible. This will help reduce contractor questions during solicitation and adjustments during construction. Some issues are unavoidable, but having clear and concise documents will help reduce the risk of mods.

Key Risk Items, Schedule

The following items were high risk items affecting the project schedule for the bridge replacement alternative. The complete risk register can be viewed in Appendix A.

- EX31 – Adequacy of Project Funds

  Discussion: A delay in receiving projects funds would result in schedule delays. This risk is similar to Risk 16 regarding availability of State funding. This likelihood is possible, as this project may not be a national priority which may result in a delay due to funding.

  Risk Reduction Measures: Communication with the vertical team will help to finalize a plan going forward on how this project might be funded. A realistic plan and timeline should be established prior to any funding request to ensure the proper escalation is applied.

- ES15 – Schedule

  Discussion: The current schedule developed for the project includes only an estimated total duration. It is very likely once a more detailed schedule is developed for the project that there will be significant impacts once all major items have been accounted for.

  Risk Reduction Measures: Build and refine the schedule as soon as details are flushed out regarding the design. Contacting other USACE districts and possibly the MCX to check on recent schedules built for a similar type of bridge construction. Reaching out to industry to discuss all facets of the project, in a generic manner of course, could also shed some light on the schedule and how it has been prepared to allow for revisions that could reduce the risk.

- PM16 – Coordinate with State

  Discussion: There would be a schedule risk associated with any delays caused by lack of state funding. Being a high priority State project, it is unlikely this will be the case here, but if it were to happen, it would have significant impact to the project schedule.

  Risk Reduction Measures: Close contact with the State and open communication can help reduce risk regarding project funding and when we might receive it.

Total Project Cost Summary

The following table portrays the full costs of the project features based on the anticipated contracts for the Program Year (FY20). The costs are intended to address the congressional requests of estimates to complete the project. Costs are in thousands of dollars.

The 43% and 40% contingency for both the Bridge Rehabilitation and Bridge Replacement plans, respectively, is based on the 90% confidence level as stated earlier. A separate Total Project Cost Summary was prepared for the Bourne and Sagamore Bridges for each the rehabilitation and replacement alternatives.

Table 2 - Cost Summary

BRIDGE REHABILITATION – BOURNE BRIDGE

ACCT	DESCRIPTION		COST ($K)	CONTG ($K)	TOTALS($K)
01	Lands & Damages	0%	0	0	0
08	Roads, Railroads & Bridges	43%	263,601	113,348	376,949
	Non-construction Costs				
30	Planning, Engineering & Design**	43%	14,259	6,131	20,390
31	Supervision & Administration**	43%	6,919	2,975	9,894
	Summary 30 & 31 Account		**21,178**	**9,106**	**30,284**
Estimated Project First Cost (FY20)			**284,778**	**122,455**	**407,233**

BRIDGE REHABILITATION – SAGAMORE BRIDGE

ACCT	DESCRIPTION		COST ($K)	CONTG ($K)	TOTALS($K)
01	Lands & Damages	0%	0	0	0
08	Roads, Railroads & Bridges	43%	238,239	102,443	340,682
	Non-construction Costs				
30	Planning, Engineering & Design**	43%	12,903	5,548	18,451
31	Supervision & Administration**	43%	6,855	2,948	9,803
	Summary 30 & 31 Account		**19,758**	**8,496**	**28,254**
Estimated Project First Cost (FY20)			**257,997**	**110,939**	**368,936**

BRIDGE REPLACEMENT – BOURNE BRIDGE

ACCT	DESCRIPTION		COST ($K)	CONTG ($K)	TOTALS($K)
01	Lands & Damages	10%	6,950	695	7,645
08	Roads, Railroads & Bridges	44%	452,202	198,969	651,172
	Non-construction Costs				
30	Planning, Engineering & Design**	44%	34,216	15,055	49,270
31	Supervision & Administration**	44%	14,992	6,596	21,588
	Summary 30 & 31 Account		**49,208**	**21,651**	**70,858**

Estimated Project First Cost (FY20)	**508,360**	**221,315**	**729,675**

BRIDGE REPLACEMENT – SAGAMORE BRIDGE

ACCT	DESCRIPTION		COST ($K)	CONTG ($K)	TOTALS($K)
01	Lands & Damages	10%	6,925	693	7,618
08	Roads, Railroads & Bridges	44%	309,544	136,199	445,743
	Non-construction Costs				
30	Planning, Engineering & Design**	44%	22,586	9,938	32,524
31	Supervision & Administration**	44%	11,119	4,892	16,011
	Summary 30 & 31 Account		**33,705**	**14,830**	**48,535**
	Estimated Project First Cost (FY20)		**350,174**	**151,722**	**501,895**

PURPOSE/BACKGROUND

The purpose of the Major Rehabilitation Evaluation Study is to evaluate the existing conditions and reliability of both the Bourne and Sagamore highway bridges of the Cape Cod Canal, MA Federal Navigation Project (FNP). The study has identified the timeline and budget requirements necessary to maintain satisfactory performance of the two bridges. The Study has included a detailed analysis and evaluation of the alternatives for both rehabilitation and replacement as well as a direction forward. This Study has resulted in a Major Rehabilitation Evaluation Report. The rehabilitation alternative includes scheduled replacement of major bridge components to avoid emergency repair. The Report also includes bridge replacement as an alternative for comparison.

REPORT SCOPE

The scope of the risk analysis report is to calculate and present the cost and schedule contingencies at various confidence levels using the risk analysis processes as mandated by U.S. Army Corps of Engineers (USACE) Engineer Regulation (ER) 1110-2-1150, Engineering and Design for Civil Works, ER 1110-2-1302, Civil Works Cost Engineering, and Engineer Technical Letter 1110-2-573, Construction Cost Estimating Guide for Civil Works. The report presents the contingency results for both cost and schedule risks for all project features. The study and presentation can include or exclude consideration for operation and maintenance or life cycle costs, depending upon the program or decision document intended for funding.

Project Scope

Major Project Features for these projects include:

Bridge Rehabilitation:

08 – Roads, Railroads, and Bridges (Truss Span Deck Replacement)
08 – Roads, Railroads, and Bridges (Suspender Cable Replacement)
08 – Roads, Railroads, and Bridges (Replace Abutment Spans)
08 – Roads, Railroads, and Bridges (Bearing Replacement)
08 – Roads, Railroads, and Bridges (Joint Replacement)
08 – Roads, Railroads, and Bridges (Minor Steel Truss Repairs)
08 – Roads, Railroads, and Bridges (Major Steel Truss Repairs)
08 – Roads, Railroads, and Bridges (Paving)
08 – Roads, Railroads, and Bridges (Maintenance Painting of Structural Steel)
08 – Roads, Railroads, and Bridges (Complete Painting of Structural Steel)
02 – Relocations (Utilities)

Bridge Replacement:

08 – Roads, Railroads, and Bridges (General Conditions)
08 – Roads, Railroads, and Bridges (Abutments/Piers)
08 – Roads, Railroads, and Bridges (Structural)
08 – Roads, Railroads, and Bridges (Superstructure)
08 – Roads, Railroads, and Bridges (Demo Existing Bridge)
08 – Roads, Railroads, and Bridges (Approaches [MASSDOT])
02 – Relocations (Utilities)
22 – Cultural Resource Preservation (Environmental and Cultural Restoration and/or Mitigation)

Detailed Risk Register

It should be noted that there are real estate costs and associated contingencies for the bridge replacement alternative both of which were developed by NAE Real Estate Division. The construction contingency developed through the CSRA process will be applied to the Planning, Engineering & Design estimates as well as the Supervision & Administration.

USACE Risk Analysis Process

The risk analysis process follows the USACE Headquarters requirements as well as the guidance provided by the Cost Engineering Directory of Expertise for Civil Works (Cost Engineering MCX). The risk analysis process reflected within the risk analysis report uses probabilistic cost and schedule risk analysis methods within the framework of the Crystal Ball software. The risk analysis results are intended to serve several functions, one being the establishment of reasonable contingencies reflective of an appropriate percent confidence level to successfully accomplish the project work within that established contingency amount. Furthermore, the scope of the report includes the identification and communication of important steps, logic, key assumptions, limitations, and decisions to help ensure that risk analysis results can be appropriately interpreted.

Risk analysis results are also intended to provide project leadership with contingency information for scheduling, budgeting, and project control purposes, as well as provide tools to support decision making and risk management as the project progresses through planning and implementation. To fully recognize its benefits, cost and schedule risk analyses should be considered as an ongoing process conducted concurrent to, and iteratively with, other important project processes such as scope and execution plan development, resource planning, procurement planning, cost estimating, budgeting, and scheduling.

In addition to broadly defined risk analysis standards and recommended practices, the risk analysis is performed to meet the requirements and recommendations of the following documents and sources:

- ER 1110-2-1150, Engineering and Design for Civil Works Projects.
- ER 1110-2-1302, Civil Works Cost Engineering.
- ETL 1110-2-573, Construction Cost Estimating Guide for Civil Works.
- Cost and Schedule Risk Analysis Process guidance prepared by the USACE Cost Engineering MCX.
- Memorandum from Major General Don T. Riley (U.S. Army Director of Civil Works), dated July 3, 2007.
- Engineering and Construction Bulletin issued by James C. Dalton, P.E. (Chief, Engineering and Construction, Directorate of Civil Works), dated September 10, 2007.

METHODOLOGY/PROCESS

A CSRA meeting was held in the CENAE office on 20 April 2017. Participants include the following members:

Table 3 - PDT Risk Identification Team

Name	Office	Representing
Martin, Craig	CENAE-PPC	PPMD/Project Manager
Habel, Mark	CENAE-PDP	Planning
Oleary, Edward	CENAE-REA	Real Estate
Kammerer-Cody, Denise NAE	CENAE-PDE	Economics
Umbrell, Stephen	CENAE-EDD	Design/Tech Lead
Cullen, Megan	CENAE-EDD	Civil
Kedzierski, John	CENAE-EDD	Structural
Nguyen, Thuyen	CENAE-EDD	Structural
Gaeta, Jeffrey NAE	CENAE-EDD	Cost Engineering
Coleman, Kevin	CENAE-CDS	Construction
Johnson, Judy NAE	CENAE-PDE	Environmental
McDonald, Sean	CENAE-ODC	Cape Cod Canal

The risk analysis process for this study is intended to determine the probability of various cost outcomes and quantify the required contingency needed in the cost estimate to achieve any desired level of cost confidence. A parallel process is also used to determine the probability of various project schedule duration outcomes and quantify the required schedule contingency (float) needed in the schedule to achieve any desired level of schedule confidence.

In simple terms, contingency is an amount added to an estimate (cost and/or schedule) to allow for items, conditions, or events for which the occurrence or impact is uncertain and that experience suggests will likely result in additional costs being incurred or additional time being required. The amount of contingency included in project control plans depends, at least in part, on the project leadership's willingness to accept risk of project overruns. The less risk that project leadership is willing to accept the more contingency should be applied in the project control plans. The risk of overrun is expressed, in a probabilistic context, using confidence levels.

The Cost Engineering MCX guidance for cost and schedule risk analysis generally focuses on the 80-percent level of confidence (P80) for cost contingency calculation. It should be noted that use of P80 as a decision criteria is a risk adverse approach (whereas the use of P50 would be a risk neutral approach, and use of levels less than 50 percent would be risk seeking). Thus, a P80 confidence level results in greater contingency as compared to a P50 confidence level. In this particular case, the P90 confidence level will be utilized.

The risk analysis process uses *Monte Carlo* techniques to determine probabilities and contingency. The *Monte Carlo* techniques are facilitated computationally by a commercially available risk analysis software package (Crystal Ball) that is an add-in to Microsoft Excel. Cost estimates are packaged into an Excel format and used directly for cost risk analysis purposes. Because Crystal Ball is an Excel add-in, the schedules for each option are recreated in an Excel format from their native format. The level of detail recreated in the Excel-format schedule is sufficient for risk analysis purposes that reflect the established risk register, but generally less than that of the native format.

Detailed Risk Register

The primary steps, in functional terms, of the risk analysis process are described in the following subsections. Risk analysis results would be provided in Section 6. It should be stated that the subject matter experts that comprise the PDT applied uncertainty bounds to the deterministic cost estimate in order to characterize over project uncertainty. There was no uncertainty evaluation at the detailed cost estimate level.

Identify and Assess Risk Factors

Identifying the risk factors via the PDT are considered a qualitative process that results in establishing a risk register that serves as the document for the further study using the Crystal Ball risk software. Risk factors are events and conditions that may influence or drive uncertainty in project performance. They may be inherent characteristics or conditions of the project or external influences, events, or conditions such as weather or economic conditions. Risk factors may have either favorable or unfavorable impacts on project cost and schedule.

Checklists or historical databases of common risk factors are sometimes used to facilitate risk factor identification. However, key risk factors are often unique to a project and not readily derivable from historical information. Therefore, input from the entire PDT is obtained using creative processes such as brainstorming or other facilitated risk assessment meetings. In practice, a combination of professional judgment from the PDT and empirical data from similar projects is desirable and is considered.

A formal PDT meeting was held in CENAE on 20 April 2017 for the purposes of identifying and assessing risk factors. The initial formal meeting focused primarily on risk factor identification using brainstorming techniques, but also included some facilitated discussions based on risk factors common to projects of similar scope and geographic location. Discussions focused primarily on risk factor assessment and quantification.

Quantify Risk Factor Impacts

The quantitative impacts of risk factors on project plans are analyzed using a combination of professional judgment, empirical data, and analytical techniques. Risk factor impacts are quantified using probability distributions (density functions), because risk factors are entered into the Crystal Ball software in the form of probability density functions.

Similar to the identification and assessment process, risk factor quantification involves multiple project team disciplines and functions. However, the quantification process relies more extensively on collaboration between cost engineering, designers, and risk analysis team members with lesser inputs from other functions and disciplines.

The following is an example of the PDT quantifying risk factor impacts by using an iterative, consensus-building approach to estimate the elements of each risk factor:

- Maximum possible value for the risk factor.
- Minimum possible value for the risk factor.
- Most likely value (the statistical mode), if applicable.
- Nature of the probability density function used to approximate risk factor uncertainty.
- Mathematical correlations between risk factors.
- Affected cost estimate and schedule elements.

Risk discussions focused on the various project features as presented within the USACE Civil Works Work Breakdown Structure for cost accounting purposes. It was recognized that the various features carry differing degrees of risk as related to cost, schedule, design complexity, and design progress. The example features under study are presented in Table 4:

Table 4 - Work Breakdown Structure by Feature

Bridge Rehabilitation	
08	Roads, Railroads, and Bridges (Truss Span Deck Replacement)
08	Roads, Railroads, and Bridges (Suspender Cable Replacement)
08	Roads, Railroads, and Bridges (Replace Abutment Spans)
08	Roads, Railroads, and Bridges (Bearing Replacement)
08	Roads, Railroads, and Bridges (Joint Replacement)
08	Roads, Railroads, and Bridges (Minor Steel Truss Repairs)
08	Roads, Railroads, and Bridges (Major Steel Truss Repairs)
08	Roads, Railroads, and Bridges (Paving)
08	Roads, Railroads, and Bridges (Maintenance Painting of Structural Steel)
08	Roads, Railroads, and Bridges (Complete Painting of Structural Steel)
02	Relocations (Utilities)

Bridge Replacement	
08	Roads, Railroads, and Bridges (General Conditions)
08	Roads, Railroads, and Bridges (Abutments/Piers)
08	Roads, Railroads, and Bridges (Structural)
08	Roads, Railroads, and Bridges (Superstructure)
08	Roads, Railroads, and Bridges (Demo Existing Bridge)
08	Roads, Railroads, and Bridges (Approaches [MASSDOT])
02	Relocations (Utilities)
22	Cultural Resource Preservation (Environmental and Cultural Restoration and/or Mitigation)

The resulting product from the PDT discussions is captured within a risk register as presented in section 6 for both cost and schedule risk concerns. Note that the risk register records the PDT's risk concerns, discussions related to those concerns, and potential impacts to the current cost and schedule estimates. The concerns and discussions are meant to support the team's decisions related to event likelihood, impact, and the resulting risk levels for each risk event.

Analyze Cost Estimate and Schedule Contingency

Contingency is analyzed using the Crystal Ball software, an add-in to the Microsoft Excel format of the cost estimate and schedule. *Monte Carlo* simulations are performed by applying the risk factors (quantified as probability density functions) to the appropriate estimated cost and schedule elements identified by the PDT. Contingencies are calculated by applying only the moderate and high level risks identified for each option (i.e., low-level risks are typically not considered, but remain within the risk register to serve historical purposes as well as support follow-on risk studies as the project and risks evolve).

For the cost estimate, the contingency is calculated as the difference between the P90 cost forecast and the base cost estimate. Each option-specific contingency is then allocated on a civil works feature level based on the dollar-weighted relative risk of each feature as quantified by *Monte Carlo* simulation. Standard deviation is used as the feature-specific measure of risk for contingency allocation purposes. This approach results in a relatively larger portion of all the project feature cost contingency being allocated to features with relatively higher estimated cost uncertainty.

For schedule contingency analysis, the option schedule contingency is calculated as the difference between the P90 option duration forecast and the base schedule duration.

KEY CONSIDERATIONS AND ASSUMPTIONS

Key assumptions include the following:

- It is assumed future rehabilitation scope and costs will mimic past projects.
- The project schedule for both rehabilitation and replacement are pre-conceptual at this stage of the project. It is assumed the total duration is accurate.
- The design for both alternatives is in the pre-conceptual stage; the cost engineer estimated quantities based on discussions with Structural Design Section and professional judgment.
- There are no applicable Life Cycle costs for this project.

RISK ANALYSIS RESULTS

Risk Register

Risk is unforeseen or unknown factors that can affect a project's cost or schedule. Time and money have a direct relationship due to the time value of money. A risk register is a tool commonly used in project planning and risk analysis and serves as the basis for the risk studies and Crystal Ball risk models. The risk register describes risks in terms of cost and schedule. A summary risk register that includes typical risk events studied (high and moderate levels) is presented in this section. The risk register reflects the results of risk factor identification and assessment, risk factor quantification, and contingency analysis. A more detailed risk register is provided in Appendix A. The detailed risk registers of Appendix A include low level and unrated risks, as well as additional information regarding the specific nature and impacts of each risk.

It is important to note that a risk register can be an effective tool for managing and communicating identified risks throughout the project life cycle. As such, it is generally recommended that risk registers be updated as the designs, cost estimates, and schedule are further refined, especially on large projects with extended schedules. Recommended uses of the risk register going forward include:

- Documenting risk mitigation strategies being pursued in response to the identified risks and their assessment in terms of probability and impact.
- Providing project sponsors, stakeholders, and leadership/management with a documented framework from which risk status can be reported in the context of project controls.
- Communicating risk management issues.
- Providing a mechanism for eliciting risk analysis feedback and project control input.
- Identifying risk transfer, elimination, or mitigation actions required for implementation of risk management plans.

A correlation is a dependency that exists between two risks and may be direct or indirect. An indirect correlation is one in which large values of one risk are associated with small values of the other. Indirect correlations have correlation coefficients between 0 and -1. A direct correlation is one in which large values of one risk are associated with large values of the other. Direct correlations have correlation coefficients between 0 and 1. Correlations were not identified in this analysis.

The risk register identifies thirty one different risks that are either moderate or high risks. An abridged version of the risk register is presented below.

Detailed Risk Register

Table 5 - Risk Register (High Risk Level)

BRIDGE REHABILITATION ALTERNATIVE

BRIDGE REPLACEMENT ALTERNATIVE

Cost Risk Analysis - Cost Contingency Results

The project Cost Contingency at the 90% confidence level is 43% and 44% for the Bridge Rehabilitation and Bridge Replacement alternatives, respectively, which translates to $204,261,948 and $329,592,512of the estimated construction cost for the Bridge Rehabilitation and Bridge Replacement alternatives, respectively. It should be noted that these contingencies are for both the Bourne Bridge and Sagamore Bridge. These levels were established by analyzing the different cost risk factors that affect both projects. Cost risks that were specific to individual project features were discussed in detail. For example, risk CA1, “Consolidation” references risks associated with the design/build contract costs only; which represent approximately 10% of the total construction cost. Most of the risks apply to the entire project such as CA3, “Contract Modifications” and EX23, “Bidding Climate” which would affect all features of work. Cost contingencies can be either positive or negative. The cost sensitivity chart shows relative cost contingency of individual risks. See the cost sensitivity chart below.

BRIDGE REHABILITATION ALTERNATIVE

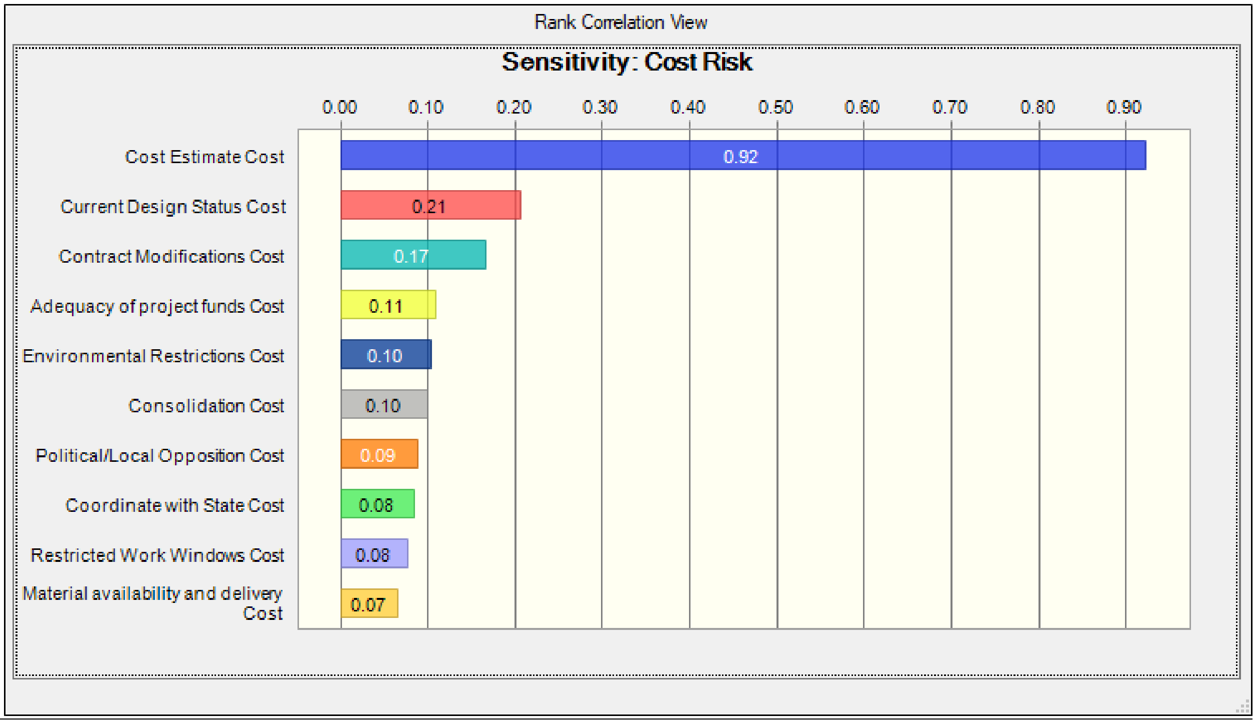


Figure 1 - Cost Risk Sensitivity Analysis

From this figure, we can see that in the Bridge Rehabilitation Alternative the top two risks that affect cost are:

- ES12 – Cost Estimate and
- TD18 – Current Design Status.

BRIDGE REPLACEMENT ALTERNATIVE

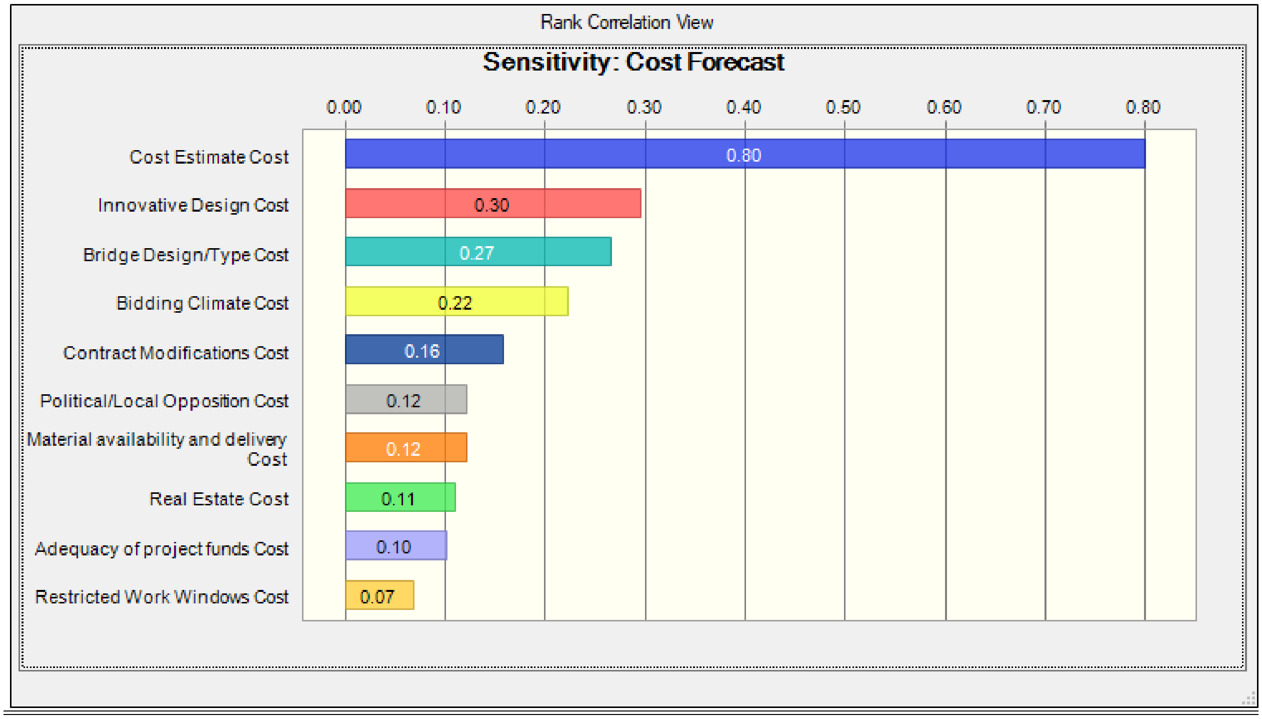


Figure 3 - Cost Risk Sensitivity Analysis

For the Bridge Replacement Alternative, the top four risks that affect costs are:

- ES14 – Cost Estimate,
- TD27 – Innovative Design,
- TD24 – Bridge Design/Type,
- EX32 – Bidding Climate.

Key Risk Items, Cost

The following were high risk items affecting the cost of the Bridge Rehabilitation alternative:

- ES12 – Cost Estimate

  Discussion: The level of design is pre-conceptual at this point. Items included in the major rehab have been generated by the Structural Section based on their Structural Reliability Analysis. The cost estimate has been put together in MII using unit prices from Mass DOT as well as other smaller bridge projects from NAE. Several items are estimated using parametric cost data from historical projects. It is very likely the current cost estimate has omitted items, underestimated the quantity, or underestimated the cost. The impacts have the potential to be significant.

Risk Reduction Measures: Build and refine cost estimate as soon as details are flushed out regarding the design. Contacting other USACE districts and possibly the MCX to check on recent estimates built for this type of bridge construction. Reaching out to industry to discuss all facets of the project, in a generic manner of course, could also shed some light on the cost estimate and how it has been prepared to allow for revisions that could reduce the risk.

- TD18 – Current Design Status

  Discussion: Current cost is based on unit price data and programmatic costs from other projects; this data may not be scalable to a project this size.

  Risk Reduction Measures: Additional review of those historical costs will be beneficial to flush out and refine the cost estimate for this rehab alternative. As each piece of the rehab is actually designed the estimate can be refined.

The following were high risk items affecting the cost of the Bridge Replacement alternative:

- ES14 – Cost Estimate

  Discussion: The level of design is conceptual at this point. Design documents include an elevation view and a cross section. The cost estimate has been put together in MII using unit prices from Mass DOT as well as other smaller bridge projects from NAE. Several items are estimated using parametric cost data from historical projects. It is very likely the current cost estimate has omitted items, underestimated the quantity, or underestimated the cost. The impacts have the potential to be significant.

  Risk Reduction Measures: Build and refine cost estimate as soon as details are flushed out regarding the design. Contacting other USACE districts and possibly the MCX to check on recent estimates built for this type of bridge construction. Reaching out to industry to discuss all facets of the project, in a generic manner of course, could also shed some light on the cost estimate and how it has been prepared to allow for revisions that could reduce the risk.

- TD27 – Innovative Design

  Discussion: There is a risk involved with designing the bridges, even if a qualified A/E is completing the design. It is likely this risk will translate to significant impacts to cost and schedule.

  Risk Reduction Measures: Coordination with the A/E in regards to bridge type and what will be designed and ultimately constructed will be helpful in mitigating this risk. A planning document will need to be completed for the replacement project and a budget established in that document which will seemlingly tie the hands of the A/E to design within a certain budget.

- TD24 – Bridge Design/Type

  Discussion: Cable-stayed bridge is one of the higher-cost alternatives. The design *will* be limited by some construction budget at the time of design. It is possible something other than cable stayed will be design/constructed, however the cost impact will be marginal based on the allowable budget.

  Risk Reduction Measures: Coordination with the A/E in regards to bridge type and what will be designed and ultimately constructed will be helpful in mitigating this risk. A planning document will need to be completed for the replacement project and a budget established in that document which will help to tie the hands of the A/E to design within a certain budget.

- EX32 – Bidding Climate

Discussion: The size and potential value of this project will likely draw any and all qualified contractors to the table. It is unlikely this would be an issue but could have moderate impact on project cost if the competition is not there during the selection process.

Risk Reduction Measures: Market research will help to mitigate this risk to see how much competition there might be around the time of solicitation.

The confidence table and curve showing the 90% confidence levels are below. Note that these results reflect only those contingencies established from the cost risk analysis.

Table 6 - Cost Contingency Analysis at Various Confidence Levels

BRIDGE REHABILITATION ALTERNATIVE

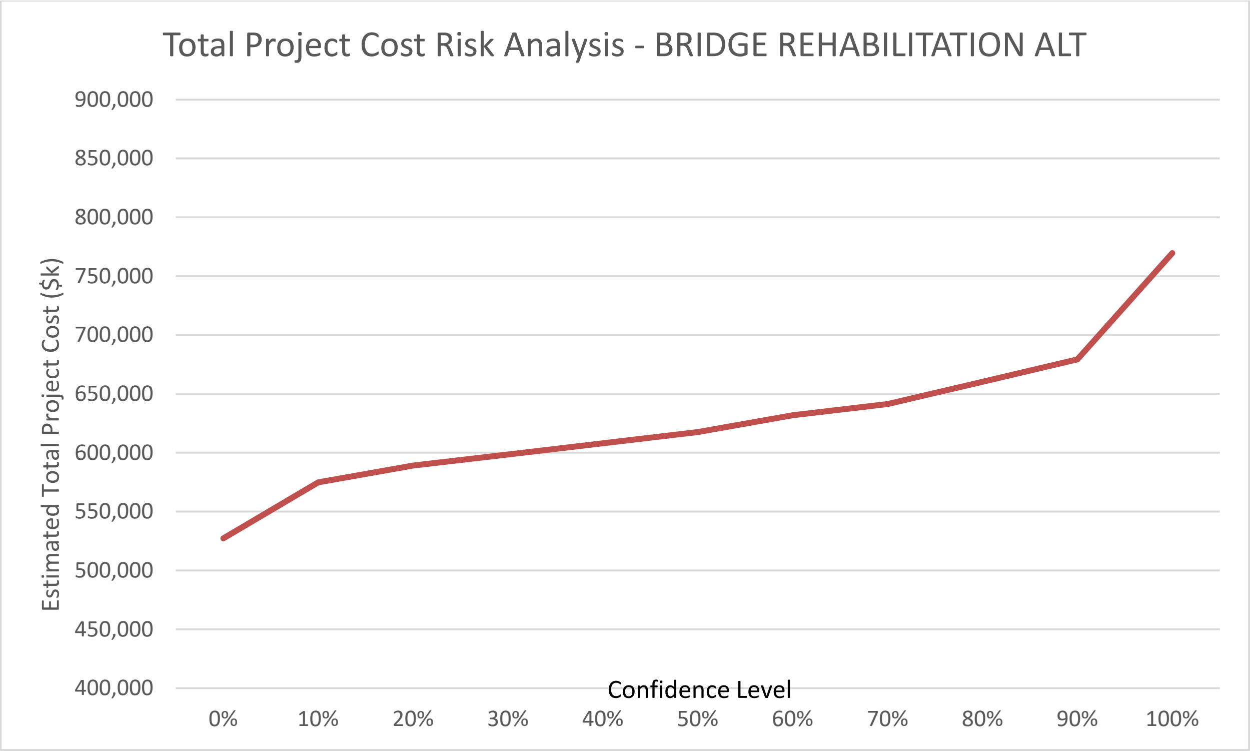
Most Likely Cost Estimate			$475,027,786
Confidence Level	Value	Contingency	Contingency
0%	$527,280,842	$52,253,056	11%
10%	$574,783,621	$99,755,835	21%
20%	$589,034,455	$114,006,669	24%
30%	$598,535,010	$123,507,224	26%
40%	$608,035,566	$133,007,780	28%
50%	$617,536,122	$142,508,336	30%
60%	$631,786,955	$156,759,169	33%
70%	$641,287,511	$166,259,725	35%
80%	$660,288,623	$185,260,837	39%
90%	$679,289,734	$204,261,948	43%
100%	$769,545,013	$294,517,227	62%

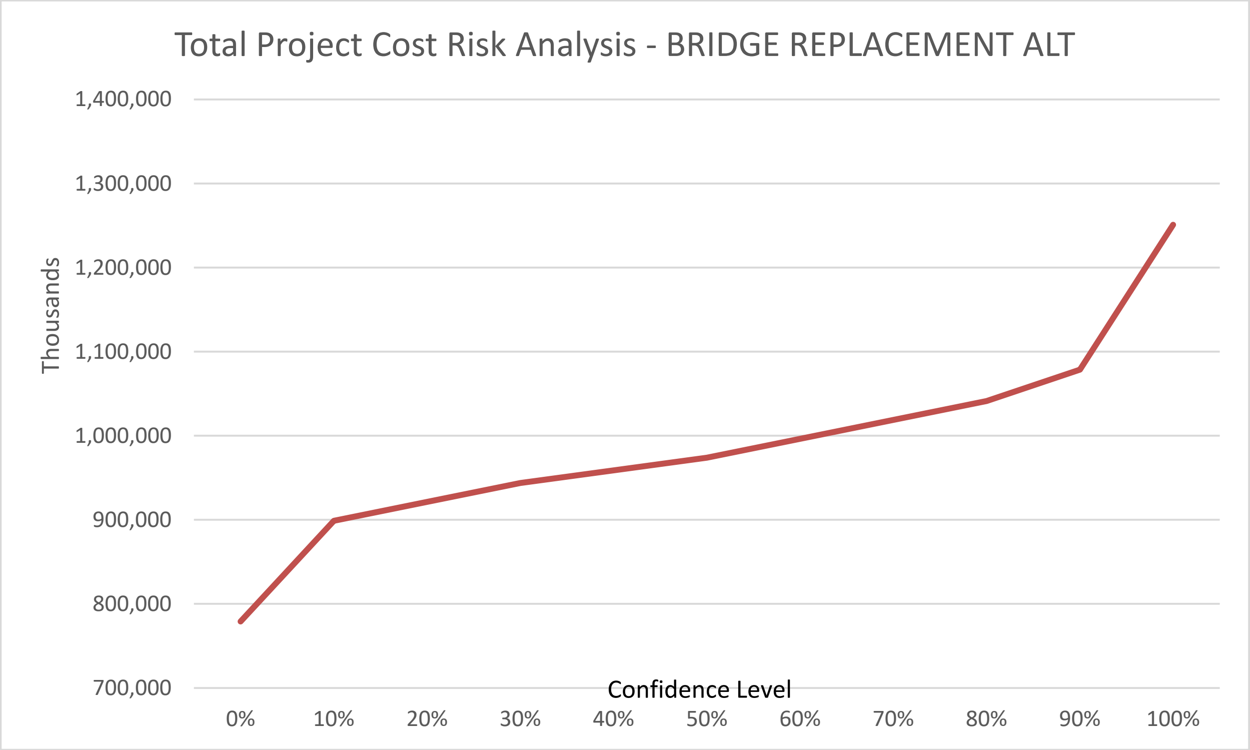
BRIDGE REPLACEMENT ALTERNATIVE

Most Likely Cost Estimate			$749,073,892
Confidence Level	Value	Contingency	Contingency
0%	$779,036,848	$29,962,956	4%
10%	$898,888,670	$149,814,778	20%
20%	$921,360,887	$172,286,995	23%
30%	$943,833,104	$194,759,212	26%
40%	$958,814,582	$209,740,690	28%
50%	$973,796,060	$224,722,168	30%
60%	$996,268,276	$247,194,384	33%
70%	$1,018,740,493	$269,666,601	36%

80%	**$1,041,212,710**	**$292,138,818**	**39%**
90%	**$1,078,666,404**	**$329,595,512**	**44%**
100%	**$1,250,953,400**	**$501,879,508**	**67%**

Table 7 - Total Project Cost Risk Analysis





Schedule Risk Analysis - Schedule Contingency Results

The project Schedule Contingency at the 90% confidence level is 94% and 59% which translates to 68 months and 71 months of additional project duration for the Bridge Rehabilitation and Bridge Replacement alternatives, respectively. This level was established by analyzing the different schedule risk factors that affect the project. The schedule sensitivity chart shows relative schedule contingency of individual risks. See the schedule sensitivity chart below.

BRIDGE REHABILITATION ALTERNATIVE

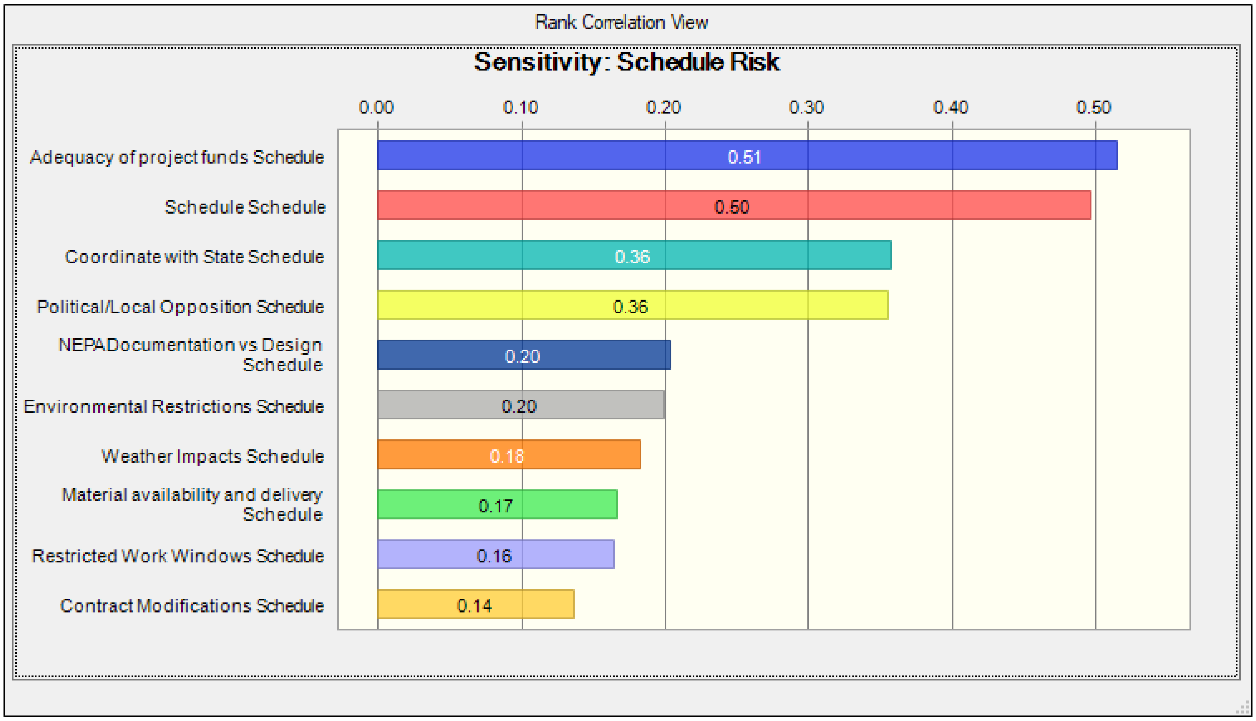


Figure 3 - Schedule Risk Sensitivity Analysis

From this figure, we can see that in the Bridge Rehabilitation Alternative the top two risks that affect schedule are:

- EX22 – Adequacy of Projects Funds and
- ES13 – Schedule.

BRIDGE REPLACEMENT ALTERNATIVE

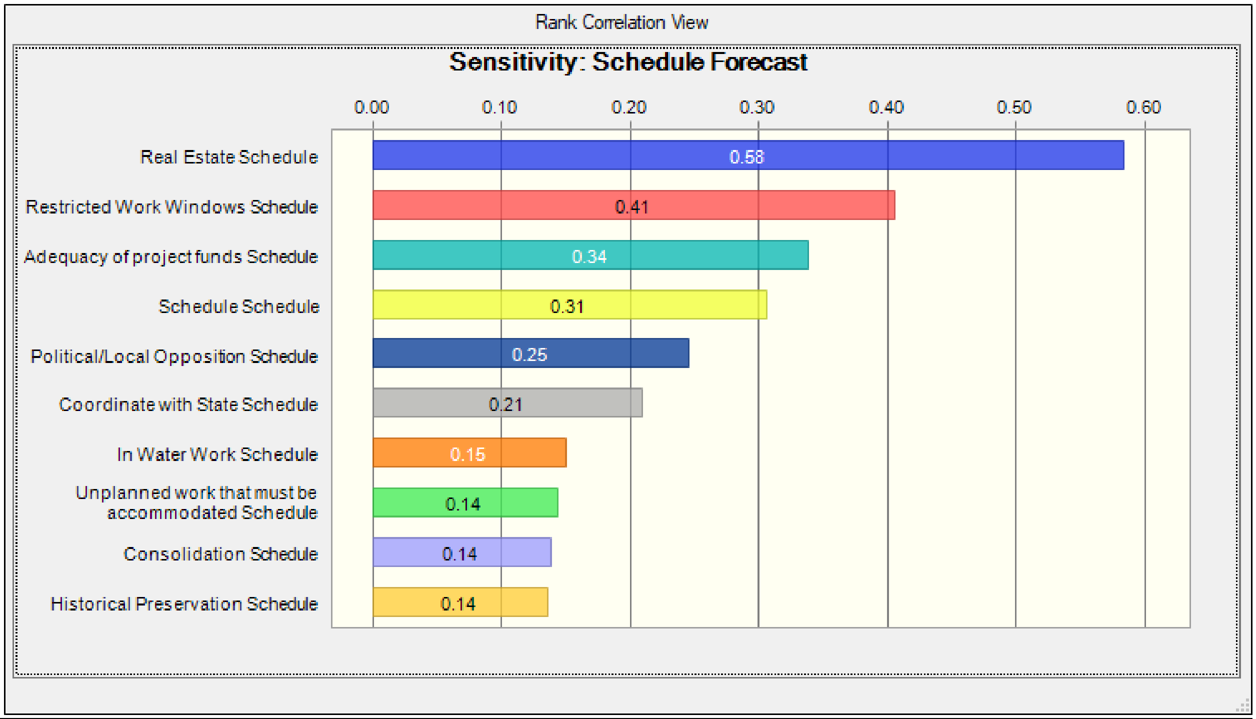


Figure 3 - Schedule Risk Sensitivity Analysis

For the Bridge Replacement Alternative, the top three risks that affect costs are:

- LD4 – Real Estate Schedule,
- CO8 – Restricted Work Windows,
- EX31 – Adequacy of Project Funds,
- ES15 – Schedule,
- EX30 – Political/Local Opposition, and
- PM16 – Coordinate with State.

Key Risk Items, Schedule

The following were high risk items affecting the project schedule of the Bridge Rehabilitation alternative:

- EX22 – Adequacy of Project Funds

  Discussion: A delay in receiving projects funds would result in schedule delays. This risk is similar to Risk 16 regarding availability of State funding. This likelihood is possible, as this project may not be a national priority which may result in a delay due to funding.

Risk Reduction Measures: Communication with the vertical team will help to finalize a plan going forward on how this project might be funded. A realistic plan and timeline should be established prior to any funding request to ensure the proper escalation is applied.

- ES13 – Schedule

  Discussion: The current schedule developed for the project includes only an estimate total duration. It is very likely once a more detailed schedule is developed for the project that there will be significant impacts once all major items have been accounted for.

  Risk Reduction Measures: Build and refine the schedule as soon as details are flushed out regarding the design. Contacting other USACE districts and possibly the MCX to check on recent schedules built for this type of bridge construction. Reaching out to industry to discuss all facets of the project, in a generic manner of course, could also shed some light on the schedule and how it has been prepared to allow for revisions that could reduce the risk.

The following were high risk items affecting the schedule of the Bridge Replacement alternative:

- LD4 – Real Estate Schedule

  Discussion: Cost and time to acquire lands, whether by USACE or State, will impact total project cost and schedule. Some duration for these acquisitions will be introduced to the project schedule in the formulation of the TPCS, however it is possible that delays will occur.

  Risk Reduction Measures: Risk can be mitigated by beginning acquisition as soon as possible after the PPA is completed. Coordination can be started during the planning stages during public notices and meetings.

- CO8 – Restricted Work Windows

  Discussion: Construction schedule accounts for delays for holidays and winter weather. Other restrictions on work windows should be known prior to start of construction. Current cost and schedule assumes work 8hrs/day M-F. It is possible additional project cost and schedule impacts will occur with numerous work window restrictions. It is also possible these impacts could be mitigated by allowing the contractor to work weekends and longer days.

  Risk Reduction Measures: During PED, any additional work windows will be flushed out and should/will be incorporated in the design documents and can be reflected in the anticipated construction schedule.

- EX31 – Adequacy of Project Funds

  Discussion: A delay in receiving projects funds would result in schedule delays. This risk is similar to Risk 16 regarding availability of State funding. This likelihood is possible, as this project may not be a national priority which may result in a delay due to funding.

  Risk Reduction Measures: Communication with the vertical team will help to finalize a plan going forward on how this project might be funded. A realistic plan and timeline should be established prior to any funding request to ensure the proper escalation is applied.

- ES15 – Schedule

  Discussion: The current schedule developed for the project includes only an estimated total duration. It is very likely once a more detailed schedule is developed for the project that there will be significant impacts once all major items have been accounted for.

Risk Reduction Measures: Build and refine the schedule as soon as details are flushed out regarding the design. Contacting other USACE districts and possibly the MCX to check on recent schedules built for a similar type of bridge construction. Reaching out to industry to discuss all facets of the project, in a generic manner of course, could also shed some light on the schedule and how it has been prepared to allow for revisions that could reduce the risk.

- EX30 – Political/Local Opposition

  Discussion: It is very likely there will be opposition to the project, especially from Cape residents, which could result in schedule delays. These impacts could be moderate if the pressure is continuous.

  Risk Reduction Measures: Public involvement will be of the utmost importance going forward to get the public involved in the project and ensure they are on the same page as the Corps and the State and help alleviate as many concerns as possible.

- PM16 – Coordinate with State

  Discussion: There would be a schedule risk associated with any delays caused by lack of state funding. Being a high priority State project, it is unlikely this will be the case here, but if it were to happen, it would have significant impact to the project schedule.

  Risk Reduction Measures: Close contact with the State and open communication can help reduce risk regarding project funding and when we might receive it.

The confidence table showing the 90% confidence level is below. Note that these results reflect only those contingencies established from the schedule risk analysis.

Table 7 - Cost Contingency Analysis at Various Confidence Levels

BRIDGE REHABILITATION ALTERNATIVE

Most Likely Schedule Duration			72 months
Confidence Level	**Value**	**Contingency**	**Contingency**
0%	**96 months**	**24 months**	**33%**
10%	**114 months**	**42 months**	**58%**
20%	**118 months**	**46 months**	**64%**
30%	**121 months**	**49 months**	**68%**
40%	**124 months**	**52 months**	**72%**
50%	**127 months**	**55 months**	**76%**
60%	**129 months**	**57 months**	**79%**
70%	**132 months**	**60 months**	**83%**
80%	**135 months**	**63 months**	**87%**
90%	**140 months**	**68 months**	**94%**
100%	**163 months**	**91 months**	**127%**

BRIDGE REPLACEMENT ALTERNATIVE

Most Likely Schedule Duration			120 months
Confidence Level	Value	Contingency	Contingency
0%	134 months	14 months	12%
10%	160 months	40 months	33%
20%	164 months	44 months	37%
30%	169 months	49 months	41%
40%	172 months	52 months	43%
50%	175 months	55 months	46%
60%	179 months	59 months	49%
70%	181 months	61 months	51%
80%	186 months	66 months	55%
90%	191 months	71 months	59%
100%	221 months	101 months	84%

ATTACHMENT 1

DETAILED RISK REGISTERS

Bridge Rehabilitation Alternative, NAE (New England District) Cost and Schedule Risk Register														Cost Model			Schedule Model				
						Project Cost			Project Schedule			Other Information		Cost			Schedule Duration				
RT	Ref #	CREF	Risk/Opportunity Event	Risk Event Description	PDT Discussions on Impact and Likelihood	Impact ©	Likelihood ©	Risk Level ©	Impact (S)	Likelihood (S)	Risk Level (S)	Cost Variance Distribution	Schedule Variance Distribution	Low Variance (Min)	Likely (C)	High Variance (80%H)	Low Variance (S) (Min)	Likely (S)	High Variance (S) (80%H)	Risk Quantification Discussions	Risk Mitigation Measures
Contract Acquisition (CA)																					
CA	-	1	Consolidation	Contracting Division at NAE has expressed concern over projects and the idea of consolidation. It is possible we would be required to provide separate contracts.	With the size and complexity of the projects, it is likely the PDT and PM will be able to overcome this concern. It is extremely unlikely we would be forced to utilize two contracts. If we were forced to it is likely we would experience an increase in project cost as this would require two contractors and twice the effort to oversee these efforts. It is possible there would be schedule impact during the solicitation process as NAE may not have the expertise for two simultaneous solicitations.	Moderate	Unlikely	Low	Moderate	Unlikely	Low	Uniform	Uniform	$0	$0	$14,250,834	0 Months	0 Months	3 Months	Assume design is 10% of construction cost. Assume high variance represents an additional 30% of the design/build contract costs and 3 months to cover additional management of 2nd contract and loss of consistency in process/design. Low variance is $0 and 0 months and likely value is $0 and 0 months as we have assumed one contract action will be sufficient for both bridge replacements.	Risk can be mitigated by completing the acquisition plan as soon as possible. This will be done subsequent to the planning document being finalized but this issue should be resolved as soon as possible.
CA	38	2	Acquisition Strategy	The current assumption is a design/bid/build contract, likely best value procurement.	The initial major rehab would likely be one contract. PDT assumes best value procurement; estimated PED costs in the TPCS will mirror that assumption.			#N/A			#N/A	N/A -Not Modeled	N/A -Not Modeled	N/A - Not Modeled		N/A - Not Modeled	N/A - Not Modeled		N/A - Not Modeled		
CA	44	3	Contract Modifications	With a project of this size, contract mods are unavoidable.	Due to the project size and complexity, the PDT is certain there will be contract mods during construction. Depending on what the mod is for, the impact to cost and schedule could be significant.	Significant	Certain	Relook at Basis of Estimate	Significant	Certain	Relook at Basis of Schedule	Triangular	Triangular	$14,250,834	$19,001,111	$47,502,779	2 Months	6 Months	9 Months	A contract of this size and complexity is all but certain to have modifications associated with it. The low variance is assumed to be 3% of the construction cost and the high variance is assumed to be 10% of the construction cost. Schedule impacts are assumed to be 2 months for the low variance and 9 months for the high variance while the likely impact is 6 months.	The easier way to reduce contract modifications is to make the design documents as clear and understable as possible. This will help reduce contractor questions during construction. Some issues are unavoidable, but having clear and concise documents will help reduce the risk of mods.
Lands and Damages (LD)																					
LD	183	4	Real Estate/Land Acquisition	The Bridge Rehab alternative will take place between the bridge abutments only. No real estate is required.	No risk associated with this item.			#N/A			#N/A	N/A -Not Modeled	N/A -Not Modeled	N/A - Not Modeled		N/A - Not Modeled	N/A - Not Modeled		N/A - Not Modeled		
LD	-							#N/A			#N/A			N/A - Not Modeled		N/A - Not Modeled	N/A - Not Modeled		N/A - Not Modeled		
Construction (CO)																					
CO	103	5	Contractor Staging/Storage Areas	Will the contractor require staging area(s) outside the bridge abutments?	The work that comprises the major rehab has been completed on both bridges in the past. Staging areas/storage areas exist for this type of rehab work on Corps-owned property. Risk not modeled.			#N/A			#N/A	N/A -Not Modeled	N/A -Not Modeled	N/A - Not Modeled		N/A - Not Modeled	N/A - Not Modeled		N/A - Not Modeled		
CO	-	6	Construction Means/Methods	USACE would require navigation lanes in the Cape Cod Canal remain open. Means & methods of construction would be left to the contractor.	This is something that would be accounted for by the contractor. Risk not modeled.			#N/A			#N/A	N/A -Not Modeled	N/A -Not Modeled	N/A - Not Modeled		N/A - Not Modeled	N/A - Not Modeled		N/A - Not Modeled		
CO	77	7	Restricted Work Windows	There will be restrictions on work periods throughout the construction (i.e. lane closures are not allowed between Memorial Day and Columbus Day).	Construction schedule accounts for delays for holidays and winter weather. Other restrictions on work windows should be known prior to start of construction. Current cost and schedule assumes work 8hrs/day M-F. Having to work around windows will certainly impact cost and mostly schedule.	Marginal	Certain	Relook at Basis of Estimate	Significant	Certain	Relook at Basis of Schedule	Uniform	Uniform	$0	$0	$9,500,556	0 Months	0 Months	6 Months	The construction schedule currently assumes limited work during the summer months (no lane closures will be permitted during those months). Any additional unknown restrictions on work windows have the ability to put the construcion to the right. The low variance and likely value are assumed to be zero if no additional work windows are imposed on the project. It is assumed additional work restrictions could add 12 months to the construction schedule, resulting in an addiitonal 2% to the construction cost (assumed escalation rate).	During PED, any additional work windows will be flushed out and should/will be incorporated in the design documents and can be reflected in the anticapted construction schedule.
CO	81	8	Weather Impacts	Work in this area will experience weather impacts.	While the likelihood of weather impacts are certain, they can be mitigated in the construction schedule by allowing for weather delays in those times of year when they are expected. Large weather events would continue to impact cost and schedule.	Marginal	Certain	Relook at Basis of Estimate	Marginal	Certain	Relook at Basis of Schedule	Uniform	Uniform	$0	$0	$4,750,278	0 Months	0 Months	6 Months	A certain number of weather delays will be allowed per the contract, however extreme adverse weather is possible as the construction duration will stretch over many years with many opportuniities for severe storms. The low variance and likely value are zero assuming the contractor is able to successfully work around any weather events. The risk associated with modifications captures a majority of this risk, however weather impacts have the ability affect cost and schedule. The high variance is assumed to be 1% of the construction cost and 6 months of schedule delay.	Ensure the contractor has a plan in place for emergencies such as severe weather events. This should help reduce life-safety-related emergencies. Otherwise, there isn't much that can be mitigated as far as weather is concerned.

Bridge Rehabilitation Alternative, NAE (New England District) Cost and Schedule Risk Register															Cost Model			Schedule Model			
						Project Cost			Project Schedule			Other Information		Cost			Schedule Duration				
RT	**Ref #**	**CREF**	**Risk/Opportunity Event**	**Risk Event Description**	**PDT Discussions on Impact and Likelihood**	**Impact ©**	**Likelihood ©**	**Risk Level ©**	**Impact (S)**	**Likelihood (S)**	**Risk Level (S)**	**Cost Variance Distribution**	**Schedule Variance Distribution**	**Low Variance (Min)**	**Likely (C)**	**High Variance (80%H)**	**Low Variance (S) (Min)**	**Likely (S)**	**High Variance (S) (80%H)**	**Risk Quantification Discussions**	**Risk Mitigation Measures**
CO	**88**	**9**	Site Access/Haul Routes	There are only so many options to access the site for workers and materials.	The work that comprises the major rehab has been completed on both bridges in the past with no issues regarding site access or haul routes. Risk not modeled.			**#N/A**			**#N/A**	N/A -Not Modeled	N/A -Not Modeled	N/A - Not Modeled		N/A - Not Modeled	N/A - Not Modeled		N/A - Not Modeled		
CO	**89**	**10**	Environmental Restrictions	Lead paint will be an issue during any steel repairs and painting.	Lead paint does still exist on the bridges and will have to handled accordingly. This can be mitigated to the extent possible during design of the rehab. The current cost estimate does not adequately account for lead paint abatement as the scope of the repairs is still very much unknown. The impact is expected to be moderate as not all aspects of the repair involve lead paint covered features of the bridge.	Moderate	Certain	**Relook at Basis of Estimate**	Marginal	Certain	Relook at Basis of Schedule	Triangular	Triangular	$4,750,278	$11,875,695	$23,751,389	2 Months	**6 Months**	12 Months	There is no accounting for lead paint abatement in the cost estimate. Assuming half of the rehabilitation projects will involve lead paint abatement of some sort, low variance is assumed to repressent 2% of half the rehab cost while the high variance represents 10% of those costs. The likely value is assumed to be 5% of the rehab costs.	This risk can be mitigated by reviewing actual contract awards for work on the bridges to review the impact of lead abatement and incorporate that into the cost estimate and schedule.
CO	**105**	**11**	Material availability and delivery	Lead time and availability could be an issue with steel necessary for bridge repairs.	No steel shortage is expected in the next several years however if the material were to become scarce, this could have moderate impact to both the cost and schedule.	Moderate	Unlikely	**Low**	Moderate	Unlikely	**Low**	Uniform	Uniform	$0	$0	$10,619,626	0 Months	0 Months	6 Months	The low variance and the likely value are zero, assuming there are no issues with material availability as there should be sufficient lead time in order to order and deliver any and all materials. In the case there are issues with any materials, the high variance is assumed to be 10% of the assumed material cost and a 6 month schedule delay.	Researching material availability in advance and ordering any long-lead items well in advance of their installation date.
Cost and Schedule (ES)																					
ES	**-**	**12**	Cost Estimate	Basis of Cost Estimate is unit prices and parametric data.	The level of design is pre-conceptual at this point. Items included in the major rehab have been generated by the Structural Section based on their Structural Reliability Analysis. The cost estimate has been put together in MII using unit prices from Mass DOT as well as other smaller bridge projects from NAE. Several items are estimated using parametric cost data from historical projects. It is very likely the current cost estimate has omitted items, underestimated the quantity, or underestimated the cost. The impacts have the potential to be significant.	Significant	Very Likely	**High**			**#N/A**	Triangular	N/A -Not Modeled	-$23,751,389	$0	$142,508,336	N/A - Not Modeled		N/A - Not Modeled	It is possible the cost estimate is overestimating quantities and unit prices however the cost estimate is based on extremely limited design and contains a majority of unit prices and parametric cost data. Assume low variance for cost estimate represents -5% of the construction cost and the high variance for cost estimate is 30% of the construction cost.	Build and refine cost estimate as soon as details are flushed out regarding the design. Contacting other USACE districts and possibly the MCX to check on recent estimates built for this type of bridge construction. Reaching out to industry to discuss all facets of the project, in a generic manner of course, could also shed some light on the cost estimate and how it has been prepared to allow for revisions that could reduce the risk.
ES	**-**	**13**	Schedule	Schedule is very basic and currently includes only total duration estimation.	The current schedule developed for the project includes only an estimate total duration. It is very likely once a more detailed schedule is developed for the project that there will be significant impacts once all major items have been accounted for.			**#N/A**	Significant	Very Likely	**High**	N/A -Not Modeled	Triangular	N/A - Not Modeled		N/A - Not Modeled	-6 Months	0 Months	18 Months	Similar to the cost estimate risk discussion, the schedule is based on professional judgement of the PDT and construction duration of similar work contracted by the District in the past. Whiel it is not likely to take much less time, assume 6 months less time, but could take more, assume 60 months more time over the 50 year design life for both bridges.	Build and refine the schedule as soon as details are flushed out regarding the design. Contacting other USACE districts and possibly the MCX to check on recent schedules built for this type of bridge construction. Reaching out to industry to discuss all facets of the project, in a generic manner of course, could also shed some light on the schedule and how it has been prepared to allow for revisions that could reduce the risk.
Project & Program Management (PM)																					
PM	**-**	**14**	Coordinate with State	Coordination with the State will be required for lane closures, etc.	The State has the ability to stop work in the case of extreme traffic delays, however this is unlikely but could have a significant impact to the schedule.			**#N/A**	Significant	Unlikely	**Medium**	Uniform	Uniform	$0	$0	$9,500,556	0 Months	3 Months	12 Months	There is significant coordination that will be necessary throughout the life of the project. The State will have constant input to USACE on construction and any traffic delays induced by construction. The State could put pressure on USACE to halt construction during high-traffic events. Low variance and likely values are zero assuming any projects requiring lane closures will not be allowed during summer months; however the high variance is assumed to be 2% of the construction cost, which represents additional escalation costs assumed at 2% per year on average, and 12 month schedule increase.	Close contact with the State and open communication can help reduce risk regarding lane closures and traffic impacts to forewarn them if we anticipate any additional delays or unexpected lane closures during those non-summer periods.
PM	**18/19**	**15**	PED and S&A Funding	E&D and CM costs will vary significantly from the costs assumed in TPCS.	Recent planning projects have included extensive coordination with the PM, cost engineer, and resource providers to furnish estimates for PED and S&A. With a project of this size, all the project requirements may not be known at that time. This could result in additional project costs for PED and S&A. Based on the size of the individual project compared to the overall project cost, these impacts will likely be marginal.	Marginal	Possible	**Low**			**#N/A**	Triangular	N/A -Not Modeled				N/A - Not Modeled		N/A - Not Modeled	PED and S&A values have been vetted through the Engineering and Construction divisions however it is difficult to accurately guage the design costs with a project of this size. The PED value is based on a percentage of the construction costs and the S&A costs were developed by Construction division but are based on a very rough schedule/duration. The low variance assumes X% decrease in PED and S&A costs while the high variance assumes a Y% increase in those costs. The likely value is zero, assuming the current values are sufficient.	
Regulatory & Environmental (RE)																					
RE	**-**	**16**	Endangered species	The long eared bat was found near the Sagamore Bridge abutments. Possibility of having to avoid this area during certain times of day/year.	Schedule impact possible. It is possible a limitation may be imposed that no work will permitted during the nighttime hours in the summer months. This would only impact the contractor only if they were trying to work 24/7. The likelihood is unlikely as the contractor will probably not be allowed to work 24/7. If they were, this would have a moderate impact to the schedule.			**#N/A**	Moderate	Unlikely	**Low**	N/A -Not Modeled	Triangular	N/A - Not Modeled		N/A - Not Modeled	N/A - Not Modeled		N/A - Not Modeled		
RE	**-**	**17**	Air quality	Timing issues possible to comply with air quality issues.	These issues will likely be addressed with EPA during NEPA process.			**#N/A**			**#N/A**	N/A -Not Modeled	N/A -Not Modeled	N/A - Not Modeled		N/A - Not Modeled	N/A - Not Modeled		N/A - Not Modeled		

Bridge Rehabilitation Alternative, NAE (New England District) Cost and Schedule Risk Register														Cost Model			Schedule Model				
						Project Cost			Project Schedule			Other Information		Cost			Schedule Duration				
RT	**Ref #**	**CREF**	**Risk/Opportunity Event**	**Risk Event Description**	**PDT Discussions on Impact and Likelihood**	**Impact ©**	**Likelihood ©**	**Risk Level ©**	**Impact (S)**	**Likelihood (S)**	**Risk Level (S)**	**Cost Variance Distribution**	**Schedule Variance Distribution**	**Low Variance (Min)**	**Likely (C)**	**High Variance (80%H)**	**Low Variance (S) (Min)**	**Likely (S)**	**High Variance (S) (80%H)**	**Risk Quantification Discussions**	**Risk Mitigation Measures**
TD	**-**	**18**	Current Design Status	The current design is conceptual at this point. There is a high likelihood that that as the design is flushed out, the cost of the project will be impacted.	Current cost is based on unit price data and programmatic costs from other projects; this data may not be scalable to a project this size.	Significant	Very Likely	**High**			**#N/A**	Triangular	N/A -Not Modeled	$9,500,556	$14,250,834	$47,502,779	N/A - Not Modeled		N/A - Not Modeled	The unit pricing and historical pricing information utilized in the cost estimate may not be scalable to for a project of this size. Assume low variance for current design status is 2% of the construction cost; this is minimal because there might be some "savings" realized by combining several projects into one contract. Assume high variance is 15% of construction cost. The likely value is 5% of the construction cost.	Additional review of those historical costs will be beneficial to flush out and refine the cost estiamte for this rehab alternative. As each piece of the rehab is actually designed the estimate can be refined.
TD	**-**	**19**	NEPA Documentation vs Design	Is NEPA documentation part of the design documentation. If NEPA is involved in design documentation there would be cost and schedule impacts. If not, then any redesign (not what was included in NEPA documentation) will also have cost and schedule impacts.	Either option has the possibility of cost and schedule impacts.	Marginal	Possible	**Low**	Marginal	Possible	**Low**	Triangular	Triangular	$2,375,139	$4,750,278	$9,500,556	3 Months	6 Months	12 Months	The low variance is assumed to be 0.5% of the construction cost, while the high variance is assumed to be 2% of the construction cost. The likely value is assumed to be low value as there is some cost impact expected to deal with the NEPA documentation.	
External																					
EX	**-**	**20**	Stakeholder Input/Coordination	Coordination with the state and local communities is required for traffic control, lane closures and full bridge closures.	Coordination only. No anticipated schedule or cost impact.			**#N/A**			**#N/A**	N/A -Not Modeled	N/A -Not Modeled	N/A - Not Modeled		N/A - Not Modeled	N/A - Not Modeled		N/A - Not Modeled		
EX	**205**	**21**	Political/Local Opposition	There are folks on the Cape that would prefer the project not be constructed. This has the ability to create schedule impacts.	It is very likely there will be opposition to the project which could result in schedule delays. These impacts could be moderate if the pressure is continuous.	Negligible	Very Likely	**Low**	Moderate	Very Likely	**High**	Uniform	Uniform	$0	$0	$9,500,556	0 Months	0 Months	12 Months	While it is known the State is very much in favor of this project, it is possible the locals, especially those on the Cape, will be opposed to the project. These local residents have the ability to cause problems through their opposition which could result in delays to the project. The low variance and likely value are zero assuming there are no issues with opposition while the high variance is assumed to be 2% of the construction cost, which represents a 1 year delay to the project.	Public involvement will be of the utmost importance going forward to get the public involved in the project and ensure they are on the same page as the Corps and the State and help allieviate as many concerns as possible.
EX	**-**	**22**	Adequacy of project funds	There is a possibility of not receiving funds in a timely manner resulting in delays to the design and/or the construction.	A delay in receiving projects funds would result in schedule delays. This risk is similar to Risk 16 regarding availability of State funding. This likelihood is possible, as this project may not be a national priority which may result in a delay due to funding.	Marginal	Possible	**Low**	Significant	Possible	**Medium**	Uniform	Uniform	$0	$0	$14,250,834	0 Months	0 Months	18 Months	While there is concern about the State providing funding in a timely manner, there is also concern about the Federal portion of funding being available. This project represents a vast portion of the available annual funding for all USACE projects. It is likely that if replacement is the option pushed forward that it will take a year or more to orchestrate some funding vehicle. Since it is not clear if this option will be pushed forward, the low variance and likely values are zero, while the high variance is assumed to be 3% of the construction cost (based on 2% escalation) assuming it will take 18 months or so to figure out federal funding for the project.	Communication with the vertical team will help to finalize a plan going forward on how this project might be funded. A realistic plan and timeline should be established prior to any funding request to ensure the proper escalation is applied.
EX	**203**	**23**	Bidding Climate	What contractors are available and will be available when the project is solicited.	The size and potential value of this project will likely draw any and all qualified contractors to the table. It is unlikely this would be an issue but could have moderate impact on project cost if the competition is not there during the selection process.	Marginal	Unlikely	**Low**			**#N/A**	Triangular	N/A -Not Modeled	-$23,751,389	$0	$23,751,389	N/A - Not Modeled		N/A - Not Modeled	Assume cost impact of bidding climate is 5% of construction cost. Assume best value procurement method has the ability to lower costs based on an extremely competitive offeror in a best value contract vehicle where price is an important factor but a lack of competition can also drive up prices. Assume low variance is a 5% reduction in construction cost and assume high variance is a 5% increase in construction cost.	Market research will help to mitigate this risk to see how much competition there might be for contract award.

Bridge Replacement Alternative, NAE (New England District) Cost and Schedule Risk Register															Cost Model			Schedule Model			
						Project Cost			Project Schedule			Other Information		Cost			Schedule Duration				
RT	**Ref #**	**CREF**	**Risk/Opportunity Event**	**Risk Event Description**	**PDT Discussions on Impact and Likelihood**	**Impact ©**	**Likelihood ©**	**Risk Level ©**	**Impact (S)**	**Likelihood (S)**	**Risk Level (S)**	**Cost Variance Distribution**	**Schedule Variance Distribution**	**Low Variance (Min)**	**Likely (C)**	**High Variance (80%H)**	**Low Variance (S) (Min)**	**Likely (S)**	**High Variance (S) (80%H)**	**Risk Quantification Discussions**	**Risk Mitigation Measures**
Contract Acquisition (CA)																					
CA	**-**	**1**	Consolidation	Contracting Division at NAE has expressed concern over projects and the idea of consolidation. It is possible we would be required to provide separate contracts for the two different bridges.	With the size and complexity of the projects, it is likely the PDT and PM will be able to overcome this concern. It is extremely unlikely we would be forced to utilize two contracts. If we were forced to it is likely we would experience an increase in project cost as this would require two design/build contractors and twice the effort to oversee the design and construction processes. It is possible there would be a schedule impact during the solicitation process as NAE may not have the expertise for two simultaneous solicitations.	Moderate	Unlikely	**Low**	Moderate	Unlikely	**Low**	Triangular	Triangular	-$5,618,054	$0	$14,045,135	-2 Months	0 Months	6 Months	Assume design is 7.5% of construction cost. Assume high variance represents an additional 30% of the design/build contract costs and 6 months to cover additional management of 2nd contract and loss of consistency in process/design. Assume low variance represents -10% and -2 months in the event the assumed design costs are too high. Likely value is $0 and 0 months as we have assumed one contract action will be sufficient for both bridge replacements.	Risk can be mitigated by completing the acquisition plan as soon as possible.
CA	**38**	**2**	Acquisition Strategy	The current assumption is a design/build contract with a large A/E firm experienced in complex bridge projects.	There are significant trade-offs between doing the design in-house and contracting with an A/E firm. Regardless of design, the acquisition stategy is expected to be best value. Any other acquisition strategy vehicle would be cheaper and take less time. The anticipated PED costs will reflect the effort necessary for this best value procurement.			**#N/A**			**#N/A**	N/A -Not Modeled	N/A -Not Modeled								
CA	**44**	**3**	Contract Modifications	With a project of this size, contract mods are unavoidable.	Due to the project size and complexity, the PDT is certain there will be contract mods during construction; such as differing site conditions for foundation issues or utility issues. Depending on what the mod is for, the impact to cost and schedule could be significant.	Significant	Certain	**Relook at Basis of Estimate**	Significant	Certain	Relook at Basis of Schedule	Triangular	Triangular	$14,981,478	$29,962,956	$74,907,389	2 Months	4 Months	9 Months	A contract of this size and complexity is all but certain to have modifications associated with it. The low variance is assumed to be 3% of the construction cost and the high variance is assumed to be 10% of the construction cost. Schedule impacts are assumed to be 2 months for the low variance and 9 months for the high variance.	The easier way to reduce contract modifications is to make the design documents as clear and understandable as possible. This will help reduce contractor questions during solicitation and adjustments during construction. Some issues are unavoidable, but having clear and concise documents will help reduce the risk of mods.
Lands and Damages (LD)																					
LD	**183**	**4**	Real Estate	Acquiring the land necessary for alignment of the approaches will greatly impact the real estate costs. State may be responsible for acquiring these lands which could introduce cost and delays.	Cost and time to acquire lands, whether by USACE or State, will impact total project cost and schedule. Some duration for these acquisitions will be introduced to the project schedule in the formulation of the TPCS, however it is possible that delays will occur.	Moderate	Possible	**Medium**	Moderate	Possible	**Medium**	Uniform	Uniform	$0	$0	$29,962,956	0 Months	0 Months	24 Months	There is significant real estate that needs to be acquired prior to construction of the new bridges. This is due to the approaches to both bridges on the mainland and Cape sides. Low variance and likely values are zero as there is sufficient time to allow for acquisition of these properties; however the high variance is assumed to be 2% of the construction cost, which represents additional escalation costs assumed at 2% per year on average, and 6 month schedule increase.	Risk can be mitigated by beginning acquisition as soon as possible after the PPA is completed. Coordination can be started during the planning stages during public notices and meetings.
LD	**-**	**5**	Land Acquisition	Acquiring the land necessary for alignment of the approaches could result in delays with opposition (eminent domain process).	The takings are relatively quick and would not greatly affect the assumed construction schedule (i.e. start date). It is possible there could be delays to the schedule, but they will marginal. Of course any delay to the schedule will push out the midpoint of construction which will affect the escalation of the project cost.			**#N/A**			**#N/A**	N/A -Not Modeled	N/A -Not Modeled								
Construction (CO)																					
CO	**103**	**6**	Contractor Staging/Storage Areas	Corps owns only between abutments. Where is the contractor staging/storage area(s) going to be? Do they require federal land?	Outside of tourist season you could shut down recreational paths/areas for contractor's use. During those busy times of year, additional protection would be required for pedestrians and alternate areas would be required for contractor. Needing to find these alternate locations for the contractor is very likely but would have a negligible cost impact relative to the size of the project.	Negligible	Very Likely	**Low**			**#N/A**	Triangular	N/A -Not Modeled	$100,000	$125,000	$200,000				In order to secure additional staging area(s), it is expected the contractor will need to expend some additional funds not currently accounted for in the cost estimate. The low variance is assumed to be $100k, the high variance is assumed to be $200k, and the likely value is anticipated to be $150k.	The Corps can coordinate with local land owners to help secure additional laydown areas for the contractor to use.
CO	**-**	**7**	Construction Means/Methods	USACE would require navigation lanes in the Cape Cod Canal remain open. Means & methods of construction would be left to the contractor.	This is something that would be accounted for by the contractor. Risk not modeled.			**#N/A**			**#N/A**	N/A -Not Modeled	N/A -Not Modeled								
CO	**77**	**8**	Restricted Work Windows	There will be restrictions on work periods throughout the construction.	Construction schedule accounts for delays for holidays and winter weather. Other restrictions on work windows should be known prior to start of construction. Current cost and schedule assumes work 8hrs/day M-F. It is possible additional project cost and schedule impacts will occur with numerous work window restrictions. It is also possible these impacts could be mitigated by allowing the contractor to work weekends and longer days.	Moderate	Possible	**Medium**	Moderate	Possible	**Medium**	Triangular	Triangular	-$7,490,739	$0	$14,981,478	-12 Months	0 Months	12 Months	Any additional unknown restrictions on work windows have the ability to put the construcion to the right. If additional work hours are allowed the schedule and cost of the project may be reduced by up to 12 months and 1% of the construction cost. The likely values are assumed to be zero if no additional work windows are imposed on the project. It is assumed additional work restrictions could add 12 months to the construction schedule, resulting in an additonal 2% to the construction cost (assumed escalation rate).	During PED, any additional work windows will be flushed out and should/will be incorporated in the design documents and can be reflected in the anticipated construction schedule.
CO	**81**	**9**	Weather Impacts	Work in this area will experience weather impacts.	While the likelihood of weather impacts are certain, they can be mitigated in the construction schedule by allowing for weather delays in those times of year when they are expected. Large weather events would continue to impact cost and schedule.	Marginal	Certain	**Relook at Basis of Estimate**	Marginal	Certain	Relook at Basis of Schedule	Uniform	Uniform	$0	$0	$14,981,478	0 Months	0 Months	6 Months	A certain number of weather delays will be allowed per the contract, however extreme adverse weather is possible as the construction duration will stretch over many years with many opportuniities for severe storms. The low variance and likely value are zero assuming the contractor is able to successfully work around any weather events. The risk associated with modifications captures a majority of this risk, however weather impacts have the ability affect cost and schedule. The high variance is assumed to be 1% of the construction cost and 6 months of schedule delay.	Ensure the contractor has a plan in place for emergencies such as severe weather events. This should help reduce life-safety-related emergencies. Otherwise, there isn't much that can be mitigated as far as weather is concerned.

Bridge Replacement Alternative, NAE (New England District) Cost and Schedule Risk Register														Cost Model			Schedule Model				
						Project Cost			Project Schedule			Other Information		Cost			Schedule Duration				
RT	Ref #	CREF	Risk/Opportunity Event	Risk Event Description	PDT Discussions on Impact and Likelihood	Impact ©	Likelihood ©	Risk Level ©	Impact (S)	Likelihood (S)	Risk Level (S)	Cost Variance Distribution	Schedule Variance Distribution	Low Variance (Min)	Likely (C)	High Variance (80%H)	Low Variance (S) (Min)	Likely (S)	High Variance (S) (80%H)	Risk Quantification Discussions	Risk Mitigation Measures
CO	-	10	Historical Preservation	There is a risk of uncovering historical, archeological and culturally significant artifacts while excavating for the new bridge abutments.	Finding these items is unlikely but would have significant impacts to the schedule as you would have to stop work and excavate carefully and comply with any applicable regulations.	Moderate	Unlikely	Low	Significant	Unlikely	Medium	Uniform	Uniform	$0	$0	$5,886,378	0 Months	0 Months	6 Months	The only area(s) of concern for historical preservation lie in the abutment and pier areas. Artifacts would be found during excavaction of these areas. The low variance and likely value are zero assuming no historically significant items are found. The high variance is assumed to be 25% of the excavation costs.	Again, during PED the area can be scanned for historical artifacts. If anything is uncovered, they can be incorporated into the design documents and planned for accordingly.
CO	88	11	Site Access/Haul Routes	There are only so many options to access the site for workers and materials.	This is a seasonally dependent and time of day risk. These risks can be mitigated in the estimate and schedule. There is also concern over needing to utilize local road and highways which may not be adequate for large construction vehicles/overuse.	Marginal	Likely	Meduim			#N/A	Triangular	N/A -Not Modeled	-$4,407,636	$0	$8,815,271				The replacement bridges will require access to the proposed abutments that don't currently exist. If the new approach roadways are not constructed, the contractor may have to construct temporary access roads not necessarily in the same location as the permenant roads. The low variance is assumed to be -5% if a majority of the temporary and permenant roadways are laid out in the same place. The high variance is assumed to be 10% of the construction of the new approach roads.	The local roadway improvements wilil be paid for by the State. Hopefully they can be planned for and land acquired before the start of bridge construction to allow for usage during construction.
CO	89	12	Environmental Restrictions	Lead paint will be an issue during demolition.	This is being accounted for in demolition cost.			#N/A			#N/A	N/A -Not Modeled	N/A -Not Modeled								
CO	105	13	Material availability and delivery	Lead time and availability could be an issue with cable stay bridge components and steel in general.	Fabrication and delivery of cable stay bridge components, and steel components in general, could be an issue. This will likely be mitigated through construction schedule and ordering long lead items in a timely manner; but this is dependent on having an efficient contractor. It is possible there could be moderate impacts to cost and schedule if steel is not readily available and/or fab/delivery of key components is delayed.	Moderate	Possible	Medium	Moderate	Possible	Medium	Triangular	Triangular	-$5,000,000	$0	$25,000,000	-2 Months	0 Months	6 Months	The low variance and the likely value are zero, assuming there are no issues with material availability as there should be sufficient lead time in order to order and deliver any and all materials. In the case there are issues with any materials, the high variance is assumed to be 10% of the assumed material cost and a 6 month schedule delay.	Researching material availability in advance and ordering any long-lead items well in advance of their installation date.
Cost and Schedule (ES)																					
ES	-	14	Cost Estimate	Basis of Cost Estimate is unit prices and parametric data.	The level of design is conceptual at this point. Design documents include an elevation view and a cross section. The cost estimate has been put together in MII using unit prices from Mass DOT as well as other smaller bridge projects from NAE. Several items are estimated using parametric cost data from historical projects. It is very likely the current cost estimate has omitted items, underestimated the quantity, or underestimated the cost. The impacts have the potential to be significant.	Significant	Very Likely	High			#N/A	Triangular	N/A -Not Modeled	-$37,453,695	$0	$224,722,168				It is possible the cost estimate is overestimating quantities and unit prices however the cost estimate is based on extremely limited design and contains a majority of unit prices and parametric cost data. Assume low variance for cost estimate represents -5% of the construction cost and the high variance for cost estimate is 50% of the construction cost.	Build and refine cost estimate as soon as details are flushed out regarding the design. Contacting other USACE districts and possibly the MCX to check on recent estimates built for this type of bridge construction. Reaching out to industry to discuss all facets of the project, in a generic manner of course, could also shed some light on the cost estimate and how it has been prepared to allow for revisions that could reduce the risk.
ES	-	15	Schedule	Schedule is very basic and currently includes only total duration estimation.	The current schedule developed for the project includes only an estimated total duration. It is very likely once a more detailed schedule is developed for the project that there will be significant impacts once all major items have been accounted for.			#N/A	Significant	Very Likely	High	N/A -Not Modeled	Triangular				-6 Months	0 Months	12 Months	Similar to the cost estimate risk discussion, the schedule is based on professional judgement of the PDT and construction duration of similar bridges constructed by others. At 5 years per bridge, it is not likely to take much less time, assume 6 months less time, but could take more, assume 12 months more time.	Build and refine the schedule as soon as details are flushed out regarding the design. Contacting other USACE districts and possibly the MCX to check on recent schedules built for a similar type of bridge construction. Reaching out to industry to discuss all facets of the project, in a generic manner of course, could also shed some light on the schedule and how it has been prepared to allow for revisions that could reduce the risk.
Project & Program Management (PM)																					
PM	-	16	Coordinate with State	There is a risk associated with the State having funds available in timely fashion to coordinate with our construction schedule.	There would be a schedule risk associated with any delays caused by lack of state funding. Being a high priority State project, it is unlikely this will be the case here, but if it were to happen, it would have significant impact to the project schedule.			#N/A	Significant	Unlikely	Medium	Uniform	Uniform	$0	$0	$14,981,478	0 Months	0 Months	12 Months	There is significant coordination that needs to be done in regards to project funding and receiving the State portion. This is due to the approaches to both bridges on the mainland and Cape sides. Low variance and likely values are zero as there is sufficient time to allow for acquisition of these properties; however the high variance is assumed to be 2% of the construction cost, which represents additional escalation costs assumed at 2% per year on average, and 12 month schedule increase.	Close contact with the State and open communication can help reduce risk regarding project funding and when we might receive it.
PM	18/19	17	PED and S&A Funding	E&D and CM costs will vary significantly from the costs assumed in TPCS.	Recent planning projects have included extensive coordination with the PM, cost engineer, and resource providers to furnish estimates for PED and S&A. With a project of this size, all the project requirements may not be known at that time. This could result in additional project costs for PED and S&A. Based on the size of the project, these impacts will likely be marginal.	Marginal	Possible	Low			#N/A	Triangular	N/A -Not Modeled	-$7,490,739	$0	$14,981,478	N/A - Not Modeled		N/A - Not Modeled	PED and S&A values have been vetted through the Engineering and Construction divisions however it is difficult to accurately guage the design costs with a project of this size. The PED value is based on a percentage of the construction costs and the S&A costs were developed by Construction division but are based on a very rough schedule/duration. The low variance assumes X% decrease in PED and S&A costs while the high variance assumes a Y% increase in those costs. The likely value is zero, assuming the current values are sufficient.	
PM	30	18	Unplanned work that must be accommodated	There is a risk of competing priorities for PDT members.	There are always competing priorities. The likelihood is "very likely" however the impacts will be negligible as this is a high priority project for the District. Other projects will be pushed off in order to have PDT available when necessary.	Negligible	Very Likely	Low	Negligible	Very Likely	Low	Uniform	Uniform	$0	$0	$7,490,739	0 Months	0 Months	6 Months	The design of this project will be a district priority. There is a chance there will other district priorities that may share time in the spotlight. There is a chance this project could be delayed in the design stages by competing work. Assume low variance is zero, likely value is zero (assuming no delays due to unplanned work), and assume unplanned work pushes this design 6 months to the right, which translates to 1% of the construction cost based on a 2% annual escalation impact.	Keeping this project fresh in the minds of upper management will help maintain it as district priority. The public involvement will also go a long way in maintaining that status. To keep the project from falling behind at the working level, the first level supervisors will need to be made aware of, and reminded of, the high priority of this project to keep those PDT members ununcumbered with other high priority projects.

Bridge Replacement Alternative, NAE (New England District) Cost and Schedule Risk Register														Cost Model			Schedule Model				
						Project Cost			Project Schedule			Other Information		Cost			Schedule Duration				
RT	**Ref #**	**CREF**	**Risk/Opportunity Event**	**Risk Event Description**	**PDT Discussions on Impact and Likelihood**	**Impact ©**	**Likelihood ©**	**Risk Level ©**	**Impact (S)**	**Likelihood (S)**	**Risk Level (S)**	**Cost Variance Distribution**	**Schedule Variance Distribution**	**Low Variance (Min)**	**Likely (C)**	**High Variance (80%H)**	**Low Variance (S) (Min)**	**Likely (S)**	**High Variance (S) (80%H)**	**Risk Quantification Discussions**	**Risk Mitigation Measures**
PM	**35**	**19**	Losing Key Personnel	Based on the duration of the project, there is a high likelihood of PDT turnover.	It is likely that, based on the project duration, the District will lose key personnel on this project to retirement or other opportunities. This will result in a loss of institutional knowledge which will require new PDT members ramp up on the project and all the requirements.			**#N/A**	Moderate	Very Likely	**High**	N/A -Not Modeled	Triangular				1 Months	0 Months	6 Months	Based on the attrition rate and the time it takes to hire someone and get them onboard, assume low variance of 1 month to ramp up an existing employee to the project and assume high variance of 6 months if an outside person needs to be brought in and then ramped up on the project. Likely value is 1 month as we expect some transfer of knowledge required through the life of the project.	This risk can be mitigated to the extent possible by keeping those existing PDT members engaged and on the project throughout it's life span. If a PDT member is leaving the project, for whatever reason, there should be some summarization of their work completed to date, such as a design analysis, to inform those taking over of what, exactly, has been done to date and why.
Regulatory & Environmental (RE)																					
RE	**-**	**20**	Endangered species	The northern long eared bat was found near the Sagamore Bridge abutments. Possibility of having to avoid this area during certain times of day/year.	It is possible a limitation may be imposed that no work will permitted during the nighttime hours in the summer months. This would only impact the contractor only if they were trying to work 24/7. The likelihood is unlikely as the contractor will probably not be allowed to work 24/7. If they were, this would have a moderate impact to the schedule. It was determined in subsuqent reviews of the risk register that this risk is extremely unlikely and was removed from the analysis.			**#N/A**	Moderate	Unlikely	**Low**	N/A -Not Modeled	Yes-No								
RE	**-**	**21**	Air quality	Timing issues possible to comply with air quality issues.	These issues will likely be addressed with EPA during NEPA process. This risk was not modeled.			**#N/A**			**#N/A**	N/A -Not Modeled	N/A -Not Modeled								
RE	**-**	**22**	Hazardous waste preliminary site investigation	If hazardous waste is found on any property required for construction, the property owner would be responsible for cleanup prior to construction. This could result in schedule impacts.	It is unlikely there will be any haz material found but if so, could result in moderate impacts to the cost and schedule while the cleanup is complete.	Moderate	Unlikely	**Low**	Moderate	Unlikely	**Low**	Yes-No	Yes-No	$0	$0	$22,472,217				If hazardous waste is found it will be removed prior to the start or continuation of construction for the replacement bridges. It is expected that this would push the construction to the right upwards of 18 months. This translates to a high variance of 3% of the construction cost (based on 2% escalation). The low variance is zero and the likely value is zero as no hazardous waste is expected to be found.	Soil sampling should be done as soon as is practical to ensure no hazardous waste is present on site. If it is found, a quick reaction by the PM can help mitigate any delays that might arise while the site is mitigated before construction.
RE	**-**	**23**	In Water Work	There is a possibility of having additional restrictions on water work based on the Fisheries Resources.	If there is any in-water work, it is certain that fisheries would have input on work windows and restrictions. These impacts may be moderate if the Fisheries Resources are not cooperative.			**#N/A**	Moderate	Certain	Relook at Basis of Schedule	Uniform	Uniform	$0	$0	$7,490,739	0 Months	0 Months	6 Months	It is unclear how cooperative the fisheries resources will be during application for any in-water work permits. Any delays due to the lack of cooperation from other agencies could push the start of construction to the right, resulting in delays up to 6 months.	Early coordination with the fisheries folks can bring to light what, exactly, USACE is required to do as far as permitting or work restrictions. This requirments can either be handled prior to contract award or rolled into the design documents to provide more informaiton for the contractor for successful project completion.
Technical Design (TD) / Project Scope Growth																					
TD	**46**	**24**	Bridge Design/Type	Current cost is based on cable stay bridge. What is built could be significantly different.	Cable stay bridge is one of the lower-cost alternatives. The design WILL be limited by some construction budget. It is possible something other than cable stay will be design/constructed, however the cost impact will be marginal based on the allowable budget.	Significant	Likely	**High**			**#N/A**	Triangular	N/A -Not Modeled	-$14,981,478	$0	$74,907,389	N/A - Not Modeled		N/A - Not Modeled	Limit of design will be budget, based on approved planning document providing funding for the project. During PED, it will be difficult to design vastly different structures unless the designers can stay within the allowable budget. Assume low variance for bridge design/type is 5% of the construction cost. Assume high variance for bridge design/type is 25% of construction cost. The likely value is 10% of the construction cost.	Coordination with the A/E in regards to bridge type and what will be designed and ultimately constructed will be helpful in mitigating this risk. A planning document will need to be completed for the replacement project and a budget established in that document which will help to tie the hands of the A/E to design within a certain budget.
TD	**-**	**25**	Current Design Status	The current design is conceptual at this point. There is a high likelihood that as the design is flushed out, the cost of the project will be impacted.	Current cost is based on unit price data and programmatic costs from other projects; this data may not be scalable to a project this size. This risk is modeled already in the "ES14 Cost Estimate" risk.			**#N/A**			**#N/A**	N/A -Not Modeled	N/A -Not Modeled								
TD	**-**	**26**	Design	NEPA document has a conceptual design. Actual design during design/build process may be different than conceptual and require additional coordination/review/approval.	It is likely the designer will coordinate with locals on minor aspects of the project to provide local "flavor" and input.			**#N/A**			**#N/A**	N/A -Not Modeled	N/A -Not Modeled								
TD	**60**	**27**	Innovative Design	Cable stay bridge is a complex project.	There is a risk involved with designing the bridges, even if a qualified A/E is completing the design. It is likely this risk will translate to significant impacts to cost and schedule.	Significant	Likely	**High**	Significant	Likely	**High**	Triangular	Triangular	-$37,453,695	$0	$74,907,389	0 Months	0 Months	3 Months	The design of this project, with two cable stay bridges of different lengths, is expected to be a complex and difficult project even for a qualified A/E. The high variance is assumed to be 10% of the construction cost to represent the risk associated with this complex project.	Coordination with the A/E in regards to bridge type and what will be designed and ultimately constructed will be helpful in mitigating this risk. A planning document will need to be completed for the replacement project and a budget established in that document which will seemlingly tie the hands of the A/E to design within a certain budget.

Bridge Replacement Alternative, NAE (New England District) Cost and Schedule Risk Register														Cost Model			Schedule Model				
						Project Cost			Project Schedule			Other Information		Cost			Schedule Duration				
RT	**Ref #**	**CREF**	**Risk/Opportunity Event**	**Risk Event Description**	**PDT Discussions on Impact and Likelihood**	**Impact ©**	**Likelihood ©**	**Risk Level ©**	**Impact (S)**	**Likelihood (S)**	**Risk Level (S)**	**Cost Variance Distribution**	**Schedule Variance Distribution**	**Low Variance (Min)**	**Likely (C)**	**High Variance (80%H)**	**Low Variance (S) (Min)**	**Likely (S)**	**High Variance (S) (80%H)**	**Risk Quantification Discussions**	**Risk Mitigation Measures**
TD	**-**	**28**	NEPA Documentation vs Design	Is NEPA documentation part of the design documentation. If NEPA is involved in design documentation there would be cost and schedule impacts. If not, then any redesign (not what was included in NEPA documentation) will also have cost and schedule impacts.	Either option has the possibility of cost and schedule impacts. These impacts will mainly affect cost and schedule of the design. It is possible there would be cost and schedule impacts but these impacts would be marginal when compared to the overall cost and schedule of the project.	Marginal	Possible	**Low**	Marginal	Possible	**Low**	Triangular	Triangular	-$1,404,514	$0	$11,236,108	2 Months	3 Months	6 Months	The low variance is assumed to be 0.5% of the construction cost, while the high variance is assumed to be 2% of the construction cost. The likely value is assumed to be low value as there is some cost impact expected to deal with the NEPA documentation.	
External																					
EX	**-**	**29**	Stakeholder Input/Coordination	The State has some input to the design, especially at the approaches due to real estate issues.	The bridge design and approach design would have be designed simultaneously. No risk associated with this item.			**#N/A**			**#N/A**	N/A -Not Modeled	N/A -Not Modeled								
EX	**205**	**30**	Political/Local Opposition	There are folks on the Cape that would prefer the project not be constructed. This has the ability to create schedule impacts.	It is very likely there will be opposition to the project, especially from Cape residents, which could result in schedule delays. These impacts could be moderate if the pressure is continuous.	Marginal	Very Likely	**Medium**	Moderate	Very Likely	**High**	Uniform	Uniform	$0	$0	$29,962,956	0 Months	0 Months	12 Months	While it is known the State is very much in favor of this project, it is possible the locals, especially those on the Cape, will be opposed to the project. These local residents have the ability to cause problems through their opposition which could result in delays to the project. The low variance and likely value are zero assuming there are no issues with opposition while the high variance is assumed to be 2% of the construction cost, which represents a 1 year delay to the project.	Public involvement will be of the utmost importance going forward to get the public involved in the project and ensure they are on the same page as the Corps and the State and help alleviate as many concerns as possible.
EX	**-**	**31**	Adequacy of project funds	There is a possibility of not receiving funds in a timely manner resulting in delays to the design and/or the construction.	A delay in receiving projects funds would result in schedule delays. This risk is similar to Risk 16 regarding availability of State funding. This likelihood is possible, as this project may not be a national priority which may result in a delay due to funding.	Marginal	Possible	**Low**	Significant	Possible	**Medium**	Uniform	Uniform	$0	$0	$29,962,956	0 Months	0 Months	18 Months	While there is concern about the State providing funding in a timely manner, there is also concern about the Federal portion of funding being available. This project represents a vast portion of the available annual funding for all USACE projects. It is likely that if replacement is the option pushed forward that it will take a year or more to orchastrate some funding vehicle. Since it is not clear if this option will be pushed forward, the low variance and likely values are zero, while the high variance is assumed to be 3% of the construction cost (based on 2% escalation) assuming it will take 18 months or so to figure out federal funding for the project.	Communication with the vertical team will help to finalize a plan going forward on how this project might be funded. A realistic plan and timeline should be established prior to any funding request to ensure the proper escalation is applied.
EX	**203**	**32**	Bidding Climate	What contractors are available and will be available when the project is solicited.	The size and potential value of this project will likely draw any and all qualified contractors to the table. It is unlikely this would be an issue but could have moderate impact on project cost if the competition is not there during the selection process.	Significant	Possible	**Medium**			**#N/A**	Triangular	N/A -Not Modeled	-$37,453,695	$0	$37,453,695				Assume cost impact of bidding climate is 5% of construction cost. Assume best value procurement method has the ability to lower costs based on an extremely competitive offeror in a best value contract vehicle where price is an important factor but a lack of competition can also drive up prices. Assume low variance is a 5% reduction in construction cost and assume high variance is a 5% increase in construction cost.	Market research will help to mitigate this risk to see how much competition there might be around the time of solictation.

Attachment 4

Conditional Cost Certification and Total Project Cost Summaries

WALLA WALLA COST ENGINEERING MANDATORY CENTER OF EXPERTISE

COST AGENCY TECHNICAL REVIEW CONDITIONAL CERTIFICATION STATEMENT

PN 450095

NAE – Cape Cod Canal Highway Bridges Major Rehabilitation Evaluation Report (MRER)

The Cape Cod Canal Highway Bridges Major Rehabilitation Evaluation Report (MRER), as presented by the New England District, has received a **Conditional** Cost Agency Technical Review Certification (Cost ATR), as defined by Engineer Regulation 1110-2-1302.

The referenced project has undergone a Cost ATR under the supervision of the Walla Walla District Cost Engineering Mandatory Center of Expertise (Cost MCX) team. The Cost ATR included study of the project scope, report, cost estimates, schedules, escalation, and risk-based contingencies.

Areas of concern resulting in a Conditional Certification:

- Costs have been developed to a Class 5 screening/pre-budget development level sufficient for MRER evaluation of rehabilitation versus replacement but not to the Class 3 level required for Feasibility Phase Certification/budget authorization.
- Additional design refinement and NEPA documentation will be required prior establishment of budget/funding.
- MRER has not been developed to a Feasibility Level Scope and should not be used for budgetary/funding purposes.

As of March 2, 2020, the Cost MCX conditionally certifies the estimated total project cost:

BRIDGE REHABILITATION:

FY20 Project First Cost:	$ 776,169,000
Fully Funded Costs:	$1,937,229,000

BRIDGE REPLACEMENT:

FY20 Project First Cost:	$1,231,570,000
Fully Funded Costs:	$1,713,512,000

Note: It remains the responsibility of the District to correctly reflect these cost values within the Final Report and to implement effective project management controls and implementation procedures including risk management through the period of Federal participation.

Michael P. Jacobs, PE, CCE
Chief, Cost Engineering MCX
Walla Walla District

**** TOTAL PROJECT COST SUMMARY ****

PROJECT: **Bridge Rehabilitation Alternative**
PROJECT NO P2# 450095
LOCATION: Cape Cod Canal, Massachusetts

DISTRICT: NAE District
POC: CHIEF, COST ENGINEERING, Christopher Tilley (Acting)

PREPARED: 9/11/2019
UPDATED: 2/28/2020

This Estimate reflects the scope and schedule in report; CCC Bridges Major Rehabilitation Evaluation Report September 2018

BOURNE AND SAGAMORE BRIDGES - REHABILITATION

Program Year (Budget EC): 2020
Effective Price Level Date: 1 OCT 19

Civil Works Work Breakdown Structure		**ESTIMATED COST**				**PROJECT FIRST COST (Constant Dollar Basis)**						**TOTAL PROJECT COST (FULLY FUNDED)**			
WBS NUMBER A	Civil Works Feature & Sub-Feature Description B	COST ($K) C	CNTG ($K) D	CNTG (%) E	TOTAL ($K) F	ESC (%) G	COST ($K) H	CNTG ($K) I	**TOTAL ($K) J**	Spent Thru: **1-Oct-18** ($K)	**TOTAL FIRST COST** ($K) K	INFLATED (%) L	COST ($K) M	CNTG ($K) N	FULL ($K) O
08	ROADS, RAILROADS & BRIDGES All Contra	$475,028	$204,262	43.0%	$679,290	1.9%	$484,009	$208,124	$692,133	$0	$692,133	147.3%	$1,197,168	$514,782	$1,711,950
02	RELOCATIONS (Utilities)	$17,500	$7,525	43.0%	$25,025	1.9%	$17,831	$7,667	$25,498	$0	$25,498	25.2%	$22,317	$9,596	$31,913
	#N/A	$0	$0	-	$0	-	$0	$0	$0	$0	$0	-	$0	$0	$0
	#N/A	$0	$0	-	$0	-	$0	$0	$0	$0	$0	-	$0	$0	$0
	#N/A	$0	$0	-	$0	-	$0	$0	$0	$0	$0	-	$0	$0	$0
	#N/A	$0	$0	-	$0	-	$0	$0	$0	$0	$0	-	$0	$0	$0
	#N/A	$0	$0	-	$0	-	$0	$0	$0	$0	$0	-	$0	$0	$0
	#N/A	$0	$0	-	$0	-	$0	$0	$0	$0	$0	-	$0	$0	$0
	#N/A	$0	$0	-	$0	-	$0	$0	$0	$0	$0	-	$0	$0	$0
	#N/A	$0	$0	-	$0	-	$0	$0	$0	$0	$0	-	$0	$0	$0
	#N/A	$0	$0	-	$0	-	$0	$0	$0	$0	$0	-	$0	$0	$0
	#N/A	$0	$0	-	$0	-	$0	$0	$0	$0	$0	-	$0	$0	$0
	#N/A	$0	$0	-	$0	-	$0	$0	$0	$0	$0	-	$0	$0	$0
	#N/A	$0	$0	-	$0	-	$0	$0	$0	$0	$0	-	$0	$0	$0
	CONSTRUCTION ESTIMATE TOTALS:	$492,528	$211,787		$704,315	1.9%	$501,840	$215,791	$717,631	$0	$717,631	143.0%	$1,219,484	$524,378	$1,743,862
01	LANDS AND DAMAGES	$0	$0	-	$0	-	$0	$0	$0	$0	$0	-	$0	$0	$0
30	PLANNING, ENGINEERING & DESIGN	$26,267	$11,295	43.0%	$37,561	3.4%	$27,162	$11,679	$38,841	$0	$38,841	236.6%	$91,439	$39,319	$130,758
31	CONSTRUCTION MANAGEMENT	$13,321	$5,728	43.0%	$19,048	3.4%	$13,774	$5,923	$19,697	$0	$19,697	217.9%	$43,782	$18,826	$62,608
	PROJECT COST TOTALS:	$532,115	$228,809	43.0%	$760,924		$542,776	$233,394	**$776,169**	$0	**$776,169**	149.6%	$1,354,706	$582,523	$1,937,229

______________________ **CHIEF, COST ENGINEERING, Christopher Tilley (Acting)**

______________________ **PROJECT MANAGER, Craig Martin**

______________________ **CHIEF, REAL ESTATE, Gaelen Daly**

______________________ **CHIEF, PLANNING, John Kennelly**

______________________ **CHIEF, ENGINEERING, David Margolis**

______________________ **CHIEF, OPERATIONS, Eric Pedersen**

______________________ **CHIEF, CONSTRUCTION, Sean Dolan**

______________________ **CHIEF, CONTRACTING, Sheila Winston-Vincuilla**

______________________ **CHIEF, PM-PB, Janet Harrington**

______________________ **CHIEF, DPM, Scott Acone**

ESTIMATED TOTAL PROJECT COST: **$1,937,229**

**** TOTAL PROJECT COST SUMMARY ****

PROJECT: **Sagamore Bridge Rehabilitation Alternative**
PROJECT NO P2 xxxxxx
LOCATION: Cape Cod Canal, Massachusetts

DISTRICT: NAE District
POC: CHIEF, COST ENGINEERING, Christopher Tilley (Acting)

PREPARED: 9/11/2019
UPDATED: 2/28/2020

This Estimate reflects the scope and schedule in report; CCC Bridges Major Rehabilitation Evaluation Report September 2018

Civil Works Work Breakdown Structure		ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis)						TOTAL PROJECT COST (FULLY FUNDED)			
SAGAMORE BRIDGE - REHABILITATION						Program Year (Budget EC): 2020 Effective Price Level Date: 1 OCT 19									
WBS NUMBER A	Civil Works Feature & Sub-Feature Description B	COST ($K) C	CNTG ($K) D	CNTG (%) E	TOTAL ($K) F	ESC (%) G	COST ($K) H	CNTG ($K) I	**TOTAL ($K) J**	Spent Thru: **1-Oct-18** ($K)	**TOTAL FIRST COST** ($K) K	INFLATED (%) L	COST ($K) M	CNTG ($K) N	FULL ($K) O
08	ROADS, RAILROADS & BRIDGES Contr 01	$91,571	$39,375	43.0%	$130,946	1.9%	$93,302	$40,120	$133,422	$0	$133,422	21.3%	$113,175	$48,665	$161,840
08	ROADS, RAILROADS & BRIDGES Contr 02	$7,072	$3,041	43.0%	$10,114	1.9%	$7,206	$3,099	$10,305	$0	$10,305	44.8%	$10,437	$4,488	$14,925
08	ROADS, RAILROADS & BRIDGES Contr 03	$1,980	$851	43.0%	$2,831	1.9%	$2,017	$867	$2,885	$0	$2,885	49.2%	$3,009	$1,294	$4,304
08	ROADS, RAILROADS & BRIDGES Contr 04	$7,072	$3,041	43.0%	$10,114	1.9%	$7,206	$3,099	$10,305	$0	$10,305	78.1%	$12,836	$5,520	$18,356
08	ROADS, RAILROADS & BRIDGES Contr 05	$4,321	$1,858	43.0%	$6,179	1.9%	$4,403	$1,893	$6,296	$0	$6,296	83.5%	$8,078	$3,474	$11,552
08	ROADS, RAILROADS & BRIDGES Contr 06	$21,432	$9,216	43.0%	$30,647	1.9%	$21,837	$9,390	$31,226	$0	$31,226	112.7%	$46,447	$19,972	$66,419
08	ROADS, RAILROADS & BRIDGES Contr 07	$1,980	$851	43.0%	$2,831	1.9%	$2,017	$867	$2,885	$0	$2,885	125.7%	$4,552	$1,957	$6,509
08	ROADS, RAILROADS & BRIDGES Contr 08	$7,072	$3,041	43.0%	$10,114	1.9%	$7,206	$3,099	$10,305	$0	$10,305	161.6%	$18,851	$8,106	$26,957
08	ROADS, RAILROADS & BRIDGES Contr 09	$4,321	$1,858	43.0%	$6,179	1.9%	$4,403	$1,893	$6,296	$0	$6,296	185.9%	$12,585	$5,412	$17,997
08	ROADS, RAILROADS & BRIDGES Contr 10	$7,072	$3,041	43.0%	$10,114	1.9%	$7,206	$3,099	$10,305	$0	$10,305	221.7%	$23,184	$9,969	$33,153
08	ROADS, RAILROADS & BRIDGES Contr 11	$71,175	$30,605	43.0%	$101,780	1.9%	$72,521	$31,184	$103,705	$0	$103,705	284.2%	$278,595	$119,796	$398,391
02	RELOCATIONS (Utilities)	$8,750	$3,763	43.0%	$12,513	1.9%	$8,915	$3,834	$12,749	$0	$12,749	17.8%	$10,499	$4,515	$15,014
	#N/A	$0	$0	-	$0	-	$0	$0	$0	$0	$0	-	$0	$0	$0
	#N/A	$0	$0	-	$0	-	$0	$0	$0	$0	$0	-	$0	$0	$0
	CONSTRUCTION ESTIMATE TOTALS:	$233,819	$100,542		$334,361	1.9%	$238,239	$102,443	$340,682	$0	$340,682	127.6%	$542,249	$233,167	$775,416
01	LANDS AND DAMAGES	$0	$0	-	$0	-	$0	$0	$0	$0	$0	-	$0	$0	$0
30	PLANNING, ENGINEERING & DESIGN	$12,477	$5,365	43.0%	$17,843	3.4%	$12,903	$5,548	$18,451	$0	$18,451	211.0%	$40,133	$17,257	$57,390
31	CONSTRUCTION MANAGEMENT	$6,629	$2,851	43.0%	$9,480	3.4%	$6,855	$2,948	$9,803	$0	$9,803	190.7%	$19,928	$8,569	$28,497
	PROJECT COST TOTALS:	$252,926	$108,758	43.0%	$361,684		$257,997	$110,939	**$368,936**	$0	**$368,936**	133.5%	$602,310	$258,993	$861,304

ESTIMATED TOTAL PROJECT COST: **$861,304**

_______________ **CHIEF, COST ENGINEERING, Christopher Tilley (Acting)**

_______________ **PROJECT MANAGER, Craig Martin**

_______________ **CHIEF, REAL ESTATE, Gaelen Daly**

_______________ **CHIEF, PLANNING, John Kennelly**

_______________ **CHIEF, ENGINEERING, David Margolis**

_______________ **CHIEF, OPERATIONS, Eric Pedersen**

_______________ **CHIEF, CONSTRUCTION, Sean Dolan**

_______________ **CHIEF, CONTRACTING, Sheila Winston-Vincuilla**

_______________ **CHIEF, PM-PB, Janet Harrington**

_______________ **CHIEF, DPM, Scott Acone**

**** TOTAL PROJECT COST SUMMARY ****

**** CONTRACT COST SUMMARY ****

PROJECT: Sagamore Bridge Rehabilitation Alternative
LOCATION: Cape Cod Canal, Massachusetts
This Estimate reflects the scope and schedule in report; CCC Bridges Major Rehabilitation Evaluation Report September 2018

DISTRICT: NAE District
POC: CHIEF, COST ENGINEERING, Christopher Tilley (.

PREPARED: 9/11/2019
UPDATED: 2/28/2020

Civil Works Work Breakdown Structure		**ESTIMATED COST**				**PROJECT FIRST COST (Constant Dollar Basis)**				**TOTAL PROJECT COST (FULLY FUNDED)**				
SAGAMORE BRIDGE - REHABILITATION		Estimate Prepared: Effective Price Level:			**11-Sep-19** 1-Oct-18	Program Year (Budget EC): Effective Price Level Date:			2020 1 OCT 19					
WBS NUMBER ***A***	Civil Works Feature & Sub-Feature Description ***B***	COST ($K) ***C***	CNTG ($K) ***D***	RISK BASED CNTG (%) ***E***	TOTAL ($K) ***F***	ESC (%) ***G***	COST ($K) ***H***	CNTG ($K) ***I***	TOTAL ($K) ***J***	Mid-Point Date ***P***	INFLATED (%) ***L***	COST ($K) ***M***	CNTG ($K) ***N***	FULL ($K) ***O***
	01 Contract 01: Major Rehab (25-27)													
08	Truss Span Deck Replacement	$19,515	$8,391	43.0%	$27,906	1.9%	$19,884	$8,550	$28,434	2026Q3	21.3%	$24,119	$10,371	$34,490
08	Suspender Cable Replacement	$10,692	$4,598	43.0%	$15,290	1.9%	$10,895	$4,685	$15,579	2026Q3	21.3%	$13,215	$5,682	$18,898
08	Replace Abutment Spans	$8,192	$3,523	43.0%	$11,715	1.9%	$8,347	$3,589	$11,936	2026Q3	21.3%	$10,125	$4,354	$14,478
08	Bearing Replacement	$1,167	$502	43.0%	$1,669	1.9%	$1,189	$511	$1,701	2026Q3	21.3%	$1,443	$620	$2,063
08	Joint Replacement	$1,980	$851	43.0%	$2,831	1.9%	$2,017	$867	$2,885	2026Q3	21.3%	$2,447	$1,052	$3,499
08	Minor Steel Truss Repairs	$6,194	$2,664	43.0%	$8,858	1.9%	$6,311	$2,714	$9,025	2026Q3	21.3%	$7,656	$3,292	$10,948
08	Major Steel Truss Repairs	$20,057	$8,624	43.0%	$28,681	1.9%	$20,436	$8,788	$29,224	2026Q3	21.3%	$24,789	$10,659	$35,448
08	Paving	$2,341	$1,007	43.0%	$3,348	1.9%	$2,386	$1,026	$3,411	2026Q3	21.3%	$2,894	$1,244	$4,138
08	Complete Painting of Structural Steel	$21,432	$9,216	43.0%	$30,647	1.9%	$21,837	$9,390	$31,226	2026Q3	21.3%	$26,488	$11,390	$37,878
02	RELOCATIONS (Utilities)	$8,750	$3,763	43.0%	$12,513	1.9%	$8,915	$3,834	$12,749	2025Q3	17.8%	$10,499	$4,515	$15,014
	CONSTRUCTION ESTIMATE TOTALS:	$100,321	$43,138	43.0%	**$143,458**		$102,217	$43,953	$146,171			$123,674	$53,180	$176,854
01	LANDS AND DAMAGES	$0	$0	0.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
30	PLANNING, ENGINEERING & DESIGN													
4.6%	Project Management	$4,579	$1,969	43.0%	$6,547	3.4%	$4,735	$2,036	$6,770	2023Q2	13.0%	$5,350	$2,301	$7,651
	Planning & Environmental Compliance	INC.		43.0%		0.0%		$0	$0	0	13.0%	$0	$0	$0
	Engineering & Design	INC.		43.0%		0.0%		$0	$0	0	13.0%	$0	$0	$0
	Reviews, ATRs, IEPRs, VE	INC.		43.0%		0.0%		$0	$0	0	13.0%	$0	$0	$0
	Life Cycle Updates (cost, schedule, risks)	INC.		43.0%		0.0%		$0	$0	0	13.0%	$0	$0	$0
	Contracting & Reprographics	INC.		43.0%		0.0%		$0	$0	0	13.0%	$0	$0	$0
	Engineering During Construction	INC.		43.0%		0.0%		$0	$0	0	27.7%	$0	$0	$0
	Planning During Construction	INC.		43.0%		0.0%		$0	$0	0	27.7%	$0	$0	$0
	Project Operations	INC.		43.0%		0.0%		$0	$0	0	13.0%	$0	$0	$0
31	CONSTRUCTION MANAGEMENT													
10.0%	Construction Management	$2,272	$977	43.0%	$3,249	3.4%	$2,349	$1,010	$3,360	2026Q3	27.7%	$3,000	$1,290	$4,291
	Project Operation:	INC.		43.0%		0.0%		$0	$0	0	27.7%	$0	$0	$0
	Project Management	INC.		43.0%		0.0%		$0	$0	0	27.7%	$0	$0	$0
	CONTRACT COST TOTALS:	$107,171	$46,084		$153,255		$109,301	$47,000	$156,301			$132,025	$56,771	$188,796

**** TOTAL PROJECT COST SUMMARY ****

**** CONTRACT COST SUMMARY ****

PROJECT: Sagamore Bridge Rehabilitation Alternative
LOCATION: Cape Cod Canal, Massachusetts
This Estimate reflects the scope and schedule in report; CCC Bridges Major Rehabilitation Evaluation Report September 2018

DISTRICT: NAE District
POC: CHIEF, COST ENGINEERING, Christopher Tilley (.

PREPARED: 9/11/2019
UPDATED: 2/28/2020

Civil Works Work Breakdown Structure		ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis)				TOTAL PROJECT COST (FULLY FUNDED)				
SAGAMORE BRIDGE - REHABILITATION		Estimate Prepared: Effective Price Level:			**11-Sep-19** 1-Oct-18	Program Year (Budget EC): Effective Price Level Date:			2020 1 OCT 19					
WBS NUMBER *A*	Civil Works Feature & Sub-Feature Description *B*	COST ($K) *C*	CNTG ($K) *D*	CNTG (%) *E*	TOTAL ($K) *F*	ESC (%) *G*	COST ($K) *H*	CNTG ($K) *I*	TOTAL ($K) *J*	Mid-Point Date *P*	INFLATED (%) *L*	COST ($K) *M*	CNTG ($K) *N*	FULL ($K) *O*
	02 Contract 02: Maint Paint (32)													
08	Maintenance Painting of Structural Steel	$7,072	$3,041	43.0%	$10,114	1.9%	$7,206	$3,099	$10,305	2032Q3	44.8%	$10,437	$4,488	$14,925
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	CONSTRUCTION ESTIMATE TOTALS:	$7,072	$3,041	43.0%	**$10,114**		$7,206	$3,099	$10,305			$10,437	$4,488	$14,925
01	LANDS AND DAMAGES	$0	$0	0.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
30	PLANNING, ENGINEERING & DESIGN													
5.0%	Project Management	$354	$152	43.0%	$506	3.4%	$366	$157	$523	2031Q2	53.3%	$561	$241	$802
	Planning & Environmental Compliance	INC.		43.0%		0.0%		$0	$0	0	53.3%	$0	$0	$0
	Engineering & Design	INC.		43.0%		0.0%		$0	$0	0	53.3%	$0	$0	$0
	Reviews, ATRs, IEPRs, VE	INC.		43.0%		0.0%		$0	$0	0	53.3%	$0	$0	$0
	Life Cycle Updates (cost, schedule, risks)	INC.		43.0%		0.0%		$0	$0	0	53.3%	$0	$0	$0
	Contracting & Reprographics	INC.		43.0%		0.0%		$0	$0	0	53.3%	$0	$0	$0
	Engineering During Construction	INC.		43.0%		0.0%		$0	$0	0	61.1%	$0	$0	$0
	Planning During Construction	INC.		43.0%		0.0%		$0	$0	0	61.1%	$0	$0	$0
	Project Operations	INC.		43.0%		0.0%		$0	$0	0	53.3%	$0	$0	$0
31	CONSTRUCTION MANAGEMENT													
3.7%	Construction Management	$261	$112	43.0%	$373	3.4%	$270	$116	$386	2032Q3	61.1%	$434	$187	$621
	Project Operation:	INC.		43.0%		0.0%		$0	$0	0	61.1%	$0	$0	$0
	Project Management	INC.		43.0%		0.0%		$0	$0	0	61.1%	$0	$0	$0
	CONTRACT COST TOTALS:	$7,687	$3,305		$10,992		$7,841	$3,372	$11,213			$11,432	$4,916	$16,348

**** TOTAL PROJECT COST SUMMARY ****

**** CONTRACT COST SUMMARY ****

PROJECT: Sagamore Bridge Rehabilitation Alternative
LOCATION: Cape Cod Canal, Massachusetts
This Estimate reflects the scope and schedule in report; CCC Bridges Major Rehabilitation Evaluation Report September 2018

DISTRICT: NAE District
POC: CHIEF, COST ENGINEERING, Christopher Tilley (.
PREPARED: 9/11/2019
UPDATED: 2/28/2020

Civil Works Work Breakdown Structure		ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis)				TOTAL PROJECT COST (FULLY FUNDED)				
SAGAMORE BRIDGE - REHABILITATION		Estimate Prepared: Effective Price Level:			**11-Sep-19** 1-Oct-18	Program Year (Budget EC): Effective Price Level Date:			2020 1 OCT 19					
WBS NUMBER *A*	Civil Works Feature & Sub-Feature Description *B*	COST ($K) *C*	CNTG ($K) *D*	CNTG (%) *E*	TOTAL ($K) *F*	ESC (%) *G*	COST ($K) *H*	CNTG ($K) *I*	TOTAL ($K) *J*	Mid-Point Date *P*	INFLATED (%) *L*	COST ($K) *M*	CNTG ($K) *N*	FULL ($K) *O*
	03 Contract 03: Joint Replace (33)													
08	Joint Replacement	$1,980	$851	43.0%	$2,831	1.9%	$2,017	$867	$2,885	2033Q3	49.2%	$3,009	$1,294	$4,304
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	CONSTRUCTION ESTIMATE TOTALS:	$1,980	$851	43.0%	**$2,831**		$2,017	$867	$2,885			$3,009	$1,294	$4,304
01	LANDS AND DAMAGES	$0	$0	0.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
30	PLANNING, ENGINEERING & DESIGN													
15.0%	Project Management	$297	$128	43.0%	$425	3.4%	$307	$132	$439	2032Q2	59.5%	$490	$211	$700
	Planning & Environmental Compliance	INC.		43.0%		0.0%		$0	$0	0	59.5%	$0	$0	$0
	Engineering & Design	INC.		43.0%		0.0%		$0	$0	0	59.5%	$0	$0	$0
	Reviews, ATRs, IEPRs, VE	INC.		43.0%		0.0%		$0	$0	0	59.5%	$0	$0	$0
	Life Cycle Updates (cost, schedule, risks)	INC.		43.0%		0.0%		$0	$0	0	59.5%	$0	$0	$0
	Contracting & Reprographics	INC.		43.0%		0.0%		$0	$0	0	59.5%	$0	$0	$0
	Engineering During Construction	INC.		43.0%		0.0%		$0	$0	0	67.5%	$0	$0	$0
	Planning During Construction	INC.		43.0%		0.0%		$0	$0	0	67.5%	$0	$0	$0
	Project Operations	INC.		43.0%		0.0%		$0	$0	0	59.5%	$0	$0	$0
31	CONSTRUCTION MANAGEMENT													
18.9%	Construction Management	$374	$161	43.0%	$535	3.4%	$387	$166	$553	2033Q3	67.5%	$648	$279	$927
	Project Operation:	INC.		43.0%		0.0%		$0	$0	0	67.5%	$0	$0	$0
	Project Management	INC.		43.0%		0.0%		$0	$0	0	67.5%	$0	$0	$0
	CONTRACT COST TOTALS:	$2,651	$1,140		**$3,791**		$2,711	$1,166	$3,877			$4,147	$1,783	**$5,931**

**** TOTAL PROJECT COST SUMMARY ****

**** CONTRACT COST SUMMARY ****

PROJECT: Sagamore Bridge Rehabilitation Alternative
LOCATION: Cape Cod Canal, Massachusetts
This Estimate reflects the scope and schedule in report; CCC Bridges Major Rehabilitation Evaluation Report September 2018

DISTRICT: NAE District
POC: CHIEF, COST ENGINEERING, Christopher Tilley (

PREPARED: 9/11/2019
UPDATED: 2/28/2020

Civil Works Work Breakdown Structure		ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis)				TOTAL PROJECT COST (FULLY FUNDED)				
SAGAMORE BRIDGE - REHABILITATION		Estimate Prepared: Effective Price Level:			**11-Sep-19** 1-Oct-18	Program Year (Budget EC): Effective Price Level Date:			2020 1 OCT 19	FULLY FUNDED PROJECT ESTIMATE				
WBS NUMBER *A*	Civil Works Feature & Sub-Feature Description *B*	COST ($K) *C*	CNTG ($K) *D*	CNTG (%) *E*	TOTAL ($K) *F*	ESC (%) *G*	COST ($K) *H*	CNTG ($K) *I*	TOTAL ($K) *J*	Mid-Point Date *P*	INFLATED (%) *L*	COST ($K) *M*	CNTG ($K) *N*	FULL ($K) *O*
	04 Contract 04: Maint Paint (39)													
08	Maintenance Painting of Structural Steel	$7,072	$3,041	43.0%	$10,114	1.9%	$7,206	$3,099	$10,305	2039Q3	78.1%	$12,836	$5,520	$18,356
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	CONSTRUCTION ESTIMATE TOTALS:	$7,072	$3,041	43.0%	**$10,114**		$7,206	$3,099	$10,305			$12,836	$5,520	$18,356
01	LANDS AND DAMAGES	$0	$0	0.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
30	PLANNING, ENGINEERING & DESIGN													
5.0%	Project Management	$354	$152	43.0%	$506	3.4%	$366	$157	$523	2038Q2	102.9%	$742	$319	$1,061
	Planning & Environmental Compliance	INC.		43.0%		0.0%		$0	$0	0	102.9%	$0	$0	$0
	Engineering & Design	INC.		43.0%		0.0%		$0	$0	0	102.9%	$0	$0	$0
	Reviews, ATRs, IEPRs, VE	INC.		43.0%		0.0%		$0	$0	0	102.9%	$0	$0	$0
	Life Cycle Updates (cost, schedule, risks)	INC.		43.0%		0.0%		$0	$0	0	102.9%	$0	$0	$0
	Contracting & Reprographics	INC.		43.0%		0.0%		$0	$0	0	102.9%	$0	$0	$0
	Engineering During Construction	INC.		43.0%		0.0%		$0	$0	0	113.7%	$0	$0	$0
	Planning During Construction	INC.		43.0%		0.0%		$0	$0	0	113.7%	$0	$0	$0
	Project Operations	INC.		43.0%		0.0%		$0	$0	0	102.9%	$0	$0	$0
31	CONSTRUCTION MANAGEMENT													
3.7%	Construction Management	$261	$112	43.0%	$373	3.4%	$270	$116	$386	2039Q3	113.7%	$576	$248	$824
	Project Operation:	INC.		43.0%		0.0%		$0	$0	0	113.7%	$0	$0	$0
	Project Management	INC.		43.0%		0.0%		$0	$0	0	113.7%	$0	$0	$0
	CONTRACT COST TOTALS:	$7,687	$3,305		**$10,992**		$7,841	$3,372	$11,213			$14,155	$6,086	**$20,241**

**** TOTAL PROJECT COST SUMMARY ****

**** CONTRACT COST SUMMARY ****

PROJECT: Sagamore Bridge Rehabilitation Alternative
LOCATION: Cape Cod Canal, Massachusetts
This Estimate reflects the scope and schedule in report; CCC Bridges Major Rehabilitation Evaluation Report September 2018

DISTRICT: NAE District
POC: CHIEF, COST ENGINEERING, Christopher Tilley (

PREPARED: 9/11/2019
UPDATED: 2/28/2020

Civil Works Work Breakdown Structure		**ESTIMATED COST**				**PROJECT FIRST COST (Constant Dollar Basis)**				**TOTAL PROJECT COST (FULLY FUNDED)**				
SAGAMORE BRIDGE - REHABILITATION		Estimate Prepared: Effective Price Level:			**11-Sep-19** 1-Oct-18	Program Year (Budget EC): Effective Price Level Date:			2020 1 OCT 19	FULLY FUNDED PROJECT ESTIMATE				
WBS NUMBER ***A***	Civil Works Feature & Sub-Feature Description ***B***	COST ($K) ***C***	CNTG ($K) ***D***	CNTG (%) ***E***	TOTAL ($K) ***F***	ESC (%) ***G***	COST ($K) ***H***	CNTG ($K) ***I***	TOTAL ($K) ***J***	Mid-Point Date ***P***	INFLATED (%) ***L***	COST ($K) ***M***	CNTG ($K) ***N***	FULL ($K) ***O***
	05 Contract 05: Paving & Joint Replace (40)													
08	Paving	$2,341	$1,007	43.0%	$3,348	1.9%	$2,386	$1,026	$3,411	2040Q3	83.5%	$4,377	$1,882	$6,259
08	Joint Replacement	$1,980	$851	43.0%	$2,831	1.9%	$2,017	$867	$2,885	2040Q3	83.5%	$3,701	$1,592	$5,293
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	CONSTRUCTION ESTIMATE TOTALS:	$4,321	$1,858	43.0%	**$6,179**		$4,403	$1,893	$6,296			$8,078	$3,474	$11,552
01	LANDS AND DAMAGES	$0	$0	0.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
30	PLANNING, ENGINEERING & DESIGN													
12.3%	Project Management	$531	$228	43.0%	$759	3.4%	$549	$236	$785	2039Q2	111.5%	$1,161	$499	$1,661
	Planning & Environmental Compliance	INC.		43.0%		0.0%		$0	$0	0	111.5%	$0	$0	$0
	Engineering & Design	INC.		43.0%		0.0%		$0	$0	0	111.5%	$0	$0	$0
	Reviews, ATRs, IEPRs, VE	INC.		43.0%		0.0%		$0	$0	0	111.5%	$0	$0	$0
	Life Cycle Updates (cost, schedule, risks)	INC.		43.0%		0.0%		$0	$0	0	111.5%	$0	$0	$0
	Contracting & Reprographics	INC.		43.0%		0.0%		$0	$0	0	111.5%	$0	$0	$0
	Engineering During Construction	INC.		43.0%		0.0%		$0	$0	0	122.6%	$0	$0	$0
	Planning During Construction	INC.		43.0%		0.0%		$0	$0	0	122.6%	$0	$0	$0
	Project Operations	INC.		43.0%		0.0%		$0	$0	0	111.5%	$0	$0	$0
31	CONSTRUCTION MANAGEMENT													
11.7%	Construction Management	$507	$218	43.0%	$725	3.4%	$525	$226	$750	2040Q3	122.6%	$1,168	$502	$1,670
	Project Operation:	INC.		43.0%		0.0%		$0	$0	0	122.6%	$0	$0	$0
	Project Management	INC.		43.0%		0.0%		$0	$0	0	122.6%	$0	$0	$0
	CONTRACT COST TOTALS:	$5,360	$2,305		**$7,664**		$5,477	$2,355	$7,832			$10,407	$4,475	**$14,883**

**** TOTAL PROJECT COST SUMMARY ****

**** CONTRACT COST SUMMARY ****

PROJECT: Sagamore Bridge Rehabilitation Alternative
LOCATION: Cape Cod Canal, Massachusetts
This Estimate reflects the scope and schedule in report; CCC Bridges Major Rehabilitation Evaluation Report September 2018

DISTRICT: NAE District
POC: CHIEF, COST ENGINEERING, Christopher Tilley (.

PREPARED: 9/11/2019
UPDATED: 2/28/2020

Civil Works Work Breakdown Structure		ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis)				TOTAL PROJECT COST (FULLY FUNDED)				
SAGAMORE BRIDGE - REHABILITATION		Estimate Prepared:			**11-Sep-19**	Program Year (Budget EC):			2020	FULLY FUNDED PROJECT ESTIMATE				
		Effective Price Level:			1-Oct-18	Effective Price Level Date:		1	OCT 19					
WBS NUMBER *A*	Civil Works Feature & Sub-Feature Description *B*	COST ($K) *C*	CNTG ($K) *D*	CNTG (%) *E*	TOTAL ($K) *F*	ESC (%) *G*	COST ($K) *H*	CNTG ($K) *I*	TOTAL ($K) *J*	Mid-Point Date *P*	INFLATED (%) *L*	COST ($K) *M*	CNTG ($K) *N*	FULL ($K) *O*
	06 Contract 06: Complete Paint (45)													
08	Complete Painting of Structural Steel	$21,432	$9,216	43.0%	$30,647	1.9%	$21,837	$9,390	$31,226	2045Q3	112.7%	$46,447	$19,972	$66,419
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	CONSTRUCTION ESTIMATE TOTALS:	$21,432	$9,216	43.0%	**$30,647**		$21,837	$9,390	$31,226			$46,447	$19,972	$66,419
01	LANDS AND DAMAGES	$0	$0	0.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
30	PLANNING, ENGINEERING & DESIGN													
5.0%	Project Management	$1,072	$461	43.0%	$1,532	3.4%	$1,108	$476	$1,585	2044Q2	159.7%	$2,878	$1,238	$4,116
	Planning & Environmental Compliance	INC.		43.0%		0.0%		$0	$0	0	159.7%	$0	$0	$0
	Engineering & Design	INC.		43.0%		0.0%		$0	$0	0	159.7%	$0	$0	$0
	Reviews, ATRs, IEPRs, VE	INC.		43.0%		0.0%		$0	$0	0	159.7%	$0	$0	$0
	Life Cycle Updates (cost, schedule, risks)	INC.		43.0%		0.0%		$0	$0	0	159.7%	$0	$0	$0
	Contracting & Reprographics	INC.		43.0%		0.0%		$0	$0	0	159.7%	$0	$0	$0
	Engineering During Construction	INC.		43.0%		0.0%		$0	$0	0	173.5%	$0	$0	$0
	Planning During Construction	INC.		43.0%		0.0%		$0	$0	0	173.5%	$0	$0	$0
	Project Operations	INC.		43.0%		0.0%		$0	$0	0	159.7%	$0	$0	$0
31	CONSTRUCTION MANAGEMENT													
1.9%	Construction Management	$415	$179	43.0%	$594	3.4%	$430	$185	$614	2045Q3	173.5%	$1,175	$505	$1,680
	Project Operation:	INC.		43.0%		0.0%		$0	$0	0	173.5%	$0	$0	$0
	Project Management	INC.		43.0%		0.0%		$0	$0	0	173.5%	$0	$0	$0
	CONTRACT COST TOTALS:	$22,919	$9,855		**$32,773**		$23,374	$10,051	$33,425			$50,500	$21,715	**$72,215**

**** TOTAL PROJECT COST SUMMARY ****

**** CONTRACT COST SUMMARY ****

PROJECT: Sagamore Bridge Rehabilitation Alternative
LOCATION: Cape Cod Canal, Massachusetts
This Estimate reflects the scope and schedule in report; CCC Bridges Major Rehabilitation Evaluation Report September 2018

DISTRICT: NAE District
POC: CHIEF, COST ENGINEERING, Christopher Tilley (.

PREPARED: 9/11/2019
UPDATED: 2/28/2020

Civil Works Work Breakdown Structure		**ESTIMATED COST**				**PROJECT FIRST COST (Constant Dollar Basis)**				**TOTAL PROJECT COST (FULLY FUNDED)**				
SAGAMORE BRIDGE - REHABILITATION		Estimate Prepared: Effective Price Level:			**11-Sep-19** 1-Oct-18	Program Year (Budget EC): Effective Price Level Date:			2020 1 OCT 19	FULLY FUNDED PROJECT ESTIMATE				
WBS NUMBER ***A***	Civil Works Feature & Sub-Feature Description ***B***	COST ($K) ***C***	CNTG ($K) ***D***	CNTG (%) ***E***	TOTAL ($K) ***F***	ESC (%) ***G***	COST ($K) ***H***	CNTG ($K) ***I***	TOTAL ($K) ***J***	Mid-Point Date ***P***	INFLATED (%) ***L***	COST ($K) ***M***	CNTG ($K) ***N***	FULL ($K) ***O***
	07 Contract 07: Joint Replace (47)													
08	Joint Replacement	$1,980	$851	43.0%	$2,831	1.9%	$2,017	$867	$2,885	2047Q3	125.7%	$4,552	$1,957	$6,509
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	CONSTRUCTION ESTIMATE TOTALS:	$1,980	$851	43.0%	**$2,831**		$2,017	$867	$2,885			$4,552	$1,957	$6,509
01	LANDS AND DAMAGES	$0	$0	0.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
30	PLANNING, ENGINEERING & DESIGN													
15.0%	Project Management	$297	$128	43.0%	$425	3.4%	$307	$132	$439	2046Q2	182.0%	$866	$372	$1,239
	Planning & Environmental Compliance	INC.		43.0%		0.0%		$0	$0	0	182.0%	$0	$0	$0
	Engineering & Design	INC.		43.0%		0.0%		$0	$0	0	182.0%	$0	$0	$0
	Reviews, ATRs, IEPRs, VE	INC.		43.0%		0.0%		$0	$0	0	182.0%	$0	$0	$0
	Life Cycle Updates (cost, schedule, risks)	INC.		43.0%		0.0%		$0	$0	0	182.0%	$0	$0	$0
	Contracting & Reprographics	INC.		43.0%		0.0%		$0	$0	0	182.0%	$0	$0	$0
	Engineering During Construction	INC.		43.0%		0.0%		$0	$0	0	197.0%	$0	$0	$0
	Planning During Construction	INC.		43.0%		0.0%		$0	$0	0	197.0%	$0	$0	$0
	Project Operations	INC.		43.0%		0.0%		$0	$0	0	182.0%	$0	$0	$0
31	CONSTRUCTION MANAGEMENT													
18.9%	Construction Management	$374	$161	43.0%	$535	3.4%	$387	$166	$553	2047Q3	197.0%	$1,149	$494	$1,643
	Project Operation:	INC.		43.0%		0.0%		$0	$0	0	197.0%	$0	$0	$0
	Project Management	INC.		43.0%		0.0%		$0	$0	0	197.0%	$0	$0	$0
	CONTRACT COST TOTALS:	$2,651	$1,140		**$3,791**		$2,711	$1,166	$3,877			$6,567	$2,824	**$9,391**

**** TOTAL PROJECT COST SUMMARY ****

**** CONTRACT COST SUMMARY ****

PROJECT: Sagamore Bridge Rehabilitation Alternative
LOCATION: Cape Cod Canal, Massachusetts
This Estimate reflects the scope and schedule in report; CCC Bridges Major Rehabilitation Evaluation Report September 2018

DISTRICT: NAE District
POC: CHIEF, COST ENGINEERING, Christopher Tilley (.

PREPARED: 9/11/2019
UPDATED: 2/28/2020

Civil Works Work Breakdown Structure		**ESTIMATED COST**				**PROJECT FIRST COST (Constant Dollar Basis)**				**TOTAL PROJECT COST (FULLY FUNDED)**				
SAGAMORE BRIDGE - REHABILITATION		Estimate Prepared: Effective Price Level:			**11-Sep-19** 1-Oct-18	Program Year (Budget EC): Effective Price Level Date:			2020 1 OCT 19	FULLY FUNDED PROJECT ESTIMATE				
WBS NUMBER *A*	Civil Works Feature & Sub-Feature Description *B*	COST ($K) *C*	CNTG ($K) *D*	CNTG (%) *E*	TOTAL ($K) *F*	ESC (%) *G*	COST ($K) *H*	CNTG ($K) *I*	TOTAL ($K) *J*	Mid-Point Date *P*	INFLATED (%) *L*	COST ($K) *M*	CNTG ($K) *N*	FULL ($K) *O*
	08 Contract 08: Maint Paint (52)													
08	Maintenance Painting of Structural Steel	$7,072	$3,041	43.0%	$10,114	1.9%	$7,206	$3,099	$10,305	2052Q3	161.6%	$18,851	$8,106	$26,957
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	CONSTRUCTION ESTIMATE TOTALS:	$7,072	$3,041	43.0%	**$10,114**		$7,206	$3,099	$10,305			$18,851	$8,106	$26,957
01	LANDS AND DAMAGES	$0	$0	0.0%	$ -	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
30	PLANNING, ENGINEERING & DESIGN													
5.0%	Project Management	$354	$152	43.0%	$506	3.4%	$366	$157	$523	2051Q2	246.4%	$1,267	$545	$1,812
	Planning & Environmental Compliance	INC.		43.0%		0.0%		$0	$0	0	246.4%	$0	$0	$0
	Engineering & Design	INC.		43.0%		0.0%		$0	$0	0	246.4%	$0	$0	$0
	Reviews, ATRs, IEPRs, VE	INC.		43.0%		0.0%		$0	$0	0	246.4%	$0	$0	$0
	Life Cycle Updates (cost, schedule, risks)	INC.		43.0%		0.0%		$0	$0	0	246.4%	$0	$0	$0
	Contracting & Reprographics	INC.		43.0%		0.0%		$0	$0	0	246.4%	$0	$0	$0
	Engineering During Construction	INC.		43.0%		0.0%		$0	$0	0	264.8%	$0	$0	$0
	Planning During Construction	INC.		43.0%		0.0%		$0	$0	0	264.8%	$0	$0	$0
	Project Operations	INC.		43.0%		0.0%		$0	$0	0	246.4%	$0	$0	$0
31	CONSTRUCTION MANAGEMENT													
3.7%	Construction Management	$261	$112	43.0%	373	3.4%	$270	$116	$386	2052Q3	264.8%	$984	$423	$1,406
	Project Operation:	INC.		43.0%		0.0%		$0	$0	0	264.8%	$0	$0	$0
	Project Management	INC.		43.0%		0.0%		$0	$0	0	264.8%	$0	$0	$0
	CONTRACT COST TOTALS:	$7,687	$3,305		**10,992**		$7,841	$3,372	$11,213			$21,101	$9,073	**$30,175**

**** TOTAL PROJECT COST SUMMARY ****

**** CONTRACT COST SUMMARY ****

PROJECT: Sagamore Bridge Rehabilitation Alternative
LOCATION: Cape Cod Canal, Massachusetts
This Estimate reflects the scope and schedule in report; CCC Bridges Major Rehabilitation Evaluation Report September 2018

DISTRICT: NAE District
POC: CHIEF, COST ENGINEERING, Christopher Tilley (.

PREPARED: 9/11/2019
UPDATED: 2/28/2020

Civil Works Work Breakdown Structure		**ESTIMATED COST**				**PROJECT FIRST COST (Constant Dollar Basis)**				**TOTAL PROJECT COST (FULLY FUNDED)**				
SAGAMORE BRIDGE - REHABILITATION		Estimate Prepared:			**11-Sep-19**	Program Year (Budget EC):			2020	FULLY FUNDED PROJECT ESTIMATE				
		Effective Price Level:			1-Oct-18	Effective Price Level Date:			1 OCT 19					
WBS NUMBER ***A***	Civil Works Feature & Sub-Feature Description ***B***	COST ($K) ***C***	CNTG ($K) ***D***	CNTG (%) ***E***	TOTAL ($K) ***F***	ESC (%) ***G***	COST ($K) ***H***	CNTG ($K) ***I***	TOTAL ($K) ***J***	Mid-Point Date ***P***	INFLATED (%) ***L***	COST ($K) ***M***	CNTG ($K) ***N***	FULL ($K) ***O***
	09 Contract 09: Paving & Joint Replace (55)													
08	Paving	$2,341	$1,007	43.0%	$3,348	1.9%	$2,386	$1,026	$3,411	2055Q3	185.9%	$6,819	$2,932	$9,751
08	Joint Replacement	$1,980	$851	43.0%	$2,831	1.9%	$2,017	$867	$2,885	2055Q3	185.9%	$5,766	$2,480	$8,246
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	CONSTRUCTION ESTIMATE TOTALS:	$4,321	$1,858	43.0%	**$6,179**		$4,403	$1,893	$6,296			$12,585	$5,412	$17,997
01	LANDS AND DAMAGES	$0	$0	0.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
30	PLANNING, ENGINEERING & DESIGN													
12.3%	Project Management	$531	$228	43.0%	$759	3.4%	$549	$236	$785	2054Q2	292.0%	$2,153	$926	$3,078
	Planning & Environmental Compliance	INC.		43.0%		0.0%		$0	$0	0	292.0%	$0	$0	$0
	Engineering & Design	INC.		43.0%		0.0%		$0	$0	0	292.0%	$0	$0	$0
	Reviews, ATRs, IEPRs, VE	INC.		43.0%		0.0%		$0	$0	0	292.0%	$0	$0	$0
	Life Cycle Updates (cost, schedule, risks)	INC.		43.0%		0.0%		$0	$0	0	292.0%	$0	$0	$0
	Contracting & Reprographics	INC.		43.0%		0.0%		$0	$0	0	292.0%	$0	$0	$0
	Engineering During Construction	INC.		43.0%		0.0%		$0	$0	0	312.7%	$0	$0	$0
	Planning During Construction	INC.		43.0%		0.0%		$0	$0	0	312.7%	$0	$0	$0
	Project Operations	INC.		43.0%		0.0%		$0	$0	0	292.0%	$0	$0	$0
31	CONSTRUCTION MANAGEMENT													
11.7%	Construction Management	$507	$218	43.0%	$725	3.4%	$525	$226	$750	2055Q3	312.7%	$2,165	$931	$3,096
	Project Operation:	INC.		43.0%		0.0%		$0	$0	0	312.7%	$0	$0	$0
	Project Management	INC.		43.0%		0.0%		$0	$0	0	312.7%	$0	$0	$0
	CONTRACT COST TOTALS:	$5,360	$2,305		**$7,664**		$5,477	$2,355	$7,832			$16,903	$7,268	**$24,171**

**** TOTAL PROJECT COST SUMMARY ****

**** CONTRACT COST SUMMARY ****

PROJECT: Sagamore Bridge Rehabilitation Alternative
LOCATION: Cape Cod Canal, Massachusetts
This Estimate reflects the scope and schedule in report; CCC Bridges Major Rehabilitation Evaluation Report September 2018

DISTRICT: NAE District
POC: CHIEF, COST ENGINEERING, Christopher Tilley (.

PREPARED: 9/11/2019
UPDATED: 2/28/2020

Civil Works Work Breakdown Structure		**ESTIMATED COST**				**PROJECT FIRST COST (Constant Dollar Basis)**				**TOTAL PROJECT COST (FULLY FUNDED)**				
SAGAMORE BRIDGE - REHABILITATION		Estimate Prepared: Effective Price Level:			**11-Sep-19** 1-Oct-18	Program Year (Budget EC): Effective Price Level Date:			2020 1 OCT 19	FULLY FUNDED PROJECT ESTIMATE				
WBS NUMBER **A**	Civil Works Feature & Sub-Feature Description **B**	COST ($K) **C**	CNTG ($K) **D**	CNTG (%) **E**	TOTAL ($K) **F**	ESC (%) **G**	COST ($K) **H**	CNTG ($K) **I**	TOTAL ($K) **J**	Mid-Point Date **P**	INFLATED (%) **L**	COST ($K) **M**	CNTG ($K) **N**	FULL ($K) **O**
	10 Contract 10: Maint Paint (59)													
08	Maintenance Painting of Structural Steel	$7,072	$3,041	43.0%	$10,114	1.9%	$7,206	$3,099	$10,305	2059Q3	221.7%	$23,184	$9,969	$33,153
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	CONSTRUCTION ESTIMATE TOTALS:	$7,072	$3,041	43.0%	**$10,114**		$7,206	$3,099	$10,305			$23,184	$9,969	$33,153
01	LANDS AND DAMAGES	$0	$0	0.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
30	PLANNING, ENGINEERING & DESIGN													
5.0%	Project Management	$354	$152	43.0%	$506	3.4%	$366	$157	$523	2058Q2	362.1%	$1,690	$727	$2,416
	Planning & Environmental Compliance	INC.		43.0%		0.0%		$0	$0	0	362.1%	$0	$0	$0
	Engineering & Design	INC.		43.0%		0.0%		$0	$0	0	362.1%	$0	$0	$0
	Reviews, ATRs, IEPRs, VE	INC.		43.0%		0.0%		$0	$0	0	362.1%	$0	$0	$0
	Life Cycle Updates (cost, schedule, risks)	INC.		43.0%		0.0%		$0	$0	0	362.1%	$0	$0	$0
	Contracting & Reprographics	INC.		43.0%		0.0%		$0	$0	0	362.1%	$0	$0	$0
	Engineering During Construction	INC.		43.0%		0.0%		$0	$0	0	386.5%	$0	$0	$0
	Planning During Construction	INC.		43.0%		0.0%		$0	$0	0	386.5%	$0	$0	$0
	Project Operations	INC.		43.0%		0.0%		$0	$0	0	362.1%	$0	$0	$0
31	CONSTRUCTION MANAGEMENT													
3.7%	Construction Management	$261	$112	43.0%	$373	3.4%	$270	$116	$386	2059Q3	386.5%	$1,312	$564	$1,876
	Project Operation:	INC.		43.0%		0.0%		$0	$0	0	386.5%	$0	$0	$0
	Project Management	INC.		43.0%		0.0%		$0	$0	0	386.5%	$0	$0	$0
	CONTRACT COST TOTALS:	$7,687	$3,305		**$10,992**		$7,841	$3,372	$11,213			$26,185	$11,260	**$37,445**

**** TOTAL PROJECT COST SUMMARY ****

**** CONTRACT COST SUMMARY ****

PROJECT:	Sagamore Bridge Rehabilitation Alternative	DISTRICT:	NAE District	PREPARED: 9/11/2019
LOCATION:	Cape Cod Canal, Massachusetts	POC:	CHIEF, COST ENGINEERING, Christopher Tilley (.	UPDATED: 2/28/2020

This Estimate reflects the scope and schedule in report; CCC Bridges Major Rehabilitation Evaluation Report September 2018

Civil Works Work Breakdown Structure		ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis)				TOTAL PROJECT COST (FULLY FUNDED)				
SAGAMORE BRIDGE - REHABILITATION		Estimate Prepared: Effective Price Level:			**11-Sep-19** 1-Oct-18	Program Year (Budget EC): Effective Price Level Date:			2020 1 OCT 19					
WBS NUMBER *A*	Civil Works Feature & Sub-Feature Description *B*	COST ($K) *C*	CNTG ($K) *D*	CNTG (%) *E*	TOTAL ($K) *F*	ESC (%) *G*	COST ($K) *H*	CNTG ($K) *I*	TOTAL ($K) *J*	Mid-Point Date *P*	INFLATED (%) *L*	COST ($K) *M*	CNTG ($K) *N*	FULL ($K) *O*
	11 Contract 11: Truss Deck, Floorbeam, Major Steel, Complete Paint & Joint Replace (65)													
08	Truss Span Deck Replacement	$19,515	$8,391	43.0%	$27,906	1.9%	$19,884	$8,550	$28,434	2065Q3	284.2%	$76,385	$32,846	$109,231
08	Replace Abutment Spans	$8,192	$3,523	43.0%	$11,715	1.9%	$8,347	$3,589	$11,936	2065Q3	284.2%	$32,066	$13,788	$45,854
08	Major Steel Truss Repairs	$20,057	$8,624	43.0%	$28,681	1.9%	$20,436	$8,788	$29,224	2065Q3	284.2%	$78,507	$33,758	$112,265
08	Complete Painting of Structural Steel	$21,432	$9,216	43.0%	$30,647	1.9%	$21,837	$9,390	$31,226	2065Q3	284.2%	$83,888	$36,072	$119,959
08	Joint Replacement	$1,980	$851	43.0%	$2,831	1.9%	$2,017	$867	$2,885	2065Q3	284.2%	$7,750	$3,332	$11,082
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	CONSTRUCTION ESTIMATE TOTALS:	$71,175	$30,605	43.0%	**$101,780**		$72,521	$31,184	$103,705			$278,595	$119,796	$398,391
01	LANDS AND DAMAGES	$0	$0	0.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
30	PLANNING, ENGINEERING & DESIGN													
5.3%	Project Management	$3,757	$1,615	43.0%	$5,372	3.4%	$3,885	$1,670	$5,555	2064Q2	491.4%	$22,976	$9,880	$32,855
	Planning & Environmental Compliance	INC.		43.0%		0.0%		$0	$0	0	491.4%	$0	$0	$0
	Engineering & Design	INC.		43.0%		0.0%		$0	$0	0	491.4%	$0	$0	$0
	Reviews, ATRs, IEPRs, VE	INC.		43.0%		0.0%		$0	$0	0	491.4%	$0	$0	$0
	Life Cycle Updates (cost, schedule, risks)	INC.		43.0%		0.0%		$0	$0	0	491.4%	$0	$0	$0
	Contracting & Reprographics	INC.		43.0%		0.0%		$0	$0	0	491.4%	$0	$0	$0
	Engineering During Construction	INC.		43.0%		0.0%		$0	$0	0	522.7%	$0	$0	$0
	Planning During Construction	INC.		43.0%		0.0%		$0	$0	0	522.7%	$0	$0	$0
	Project Operations	INC.		43.0%		0.0%		$0	$0	0	491.4%	$0	$0	$0
31	CONSTRUCTION MANAGEMENT													
1.6%	Construction Management	$1,136	$489	43.0%	$1,625	3.4%	$1,175	$505	$1,680	2065Q3	522.7%	$7,317	$3,146	$10,464
	Project Operation:	INC.		43.0%		0.0%		$0	$0	0	522.7%	$0	$0	$0
	Project Management	INC.		43.0%		0.0%		$0	$0	0	522.7%	$0	$0	$0
	CONTRACT COST TOTALS:	$76,068	$32,709		$108,777		$77,580	$33,360	$110,940			$308,888	$132,822	$441,710

**** TOTAL PROJECT COST SUMMARY ****

PROJECT: **Bourne Bridge Rehabilitation Alternative**
PROJECT NO P2 xxxxxx
LOCATION: Cape Cod Canal, Massachusetts

DISTRICT: NAE District **PREPARED: 9/11/2019**
POC: CHIEF, COST ENGINEERING, Christopher Tilley (Acting)
UPDATED: 2/28/2020

This Estimate reflects the scope and schedule in report; CCC Bridges Major Rehabilitation Evaluation Report September 2018

Civil Works Work Breakdown Structure		**ESTIMATED COST**				**PROJECT FIRST COST (Constant Dollar Basis)**						**TOTAL PROJECT COST (FULLY FUNDED)**			
BOURNE BRIDGE - REHABILITATION						Program Year (Budget EC): 2020 Effective Price Level Date: 1 OCT 19									
WBS NUMBER *A*	Civil Works Feature & Sub-Feature Description *B*	COST ($K) *C*	CNTG ($K) *D*	CNTG (%) *E*	TOTAL ($K) *F*	ESC (%) *G*	COST ($K) *H*	CNTG ($K) *I*	**TOTAL ($K)** *J*	Spent Thru: **1-Oct-18** ($K)	**TOTAL FIRST COST** ($K) *K*	INFLATED (%) *L*	COST ($K) *M*	CNTG ($K) *N*	FULL ($K) *O*
08	ROADS, RAILROADS & BRIDGES Contr 01	$111,075	$47,762	43.0%	$158,837	1.9%	$113,175	$48,665	$161,841	$0	$161,841	36.5%	$154,511	$66,440	$220,951
08	ROADS, RAILROADS & BRIDGES Contr 02	$5,650	$2,429	43.0%	$8,079	1.9%	$5,756	$2,475	$8,232	$0	$8,232	63.0%	$9,384	$4,035	$13,419
08	ROADS, RAILROADS & BRIDGES Contr 03	$1,938	$833	43.0%	$2,771	1.9%	$1,974	$849	$2,823	$0	$2,823	67.9%	$3,315	$1,425	$4,740
08	ROADS, RAILROADS & BRIDGES Contr 04	$5,650	$2,429	43.0%	$8,079	1.9%	$5,756	$2,475	$8,232	$0	$8,232	100.5%	$11,541	$4,963	$16,504
08	ROADS, RAILROADS & BRIDGES Contr 05	$5,162	$2,220	43.0%	$7,382	1.9%	$5,260	$2,262	$7,522	$0	$7,522	106.5%	$10,862	$4,671	$15,532
08	ROADS, RAILROADS & BRIDGES Contr 06	$17,120	$7,362	43.0%	$24,482	1.9%	$17,444	$7,501	$24,945	$0	$24,945	139.4%	$41,760	$17,957	$59,716
08	ROADS, RAILROADS & BRIDGES Contr 07	$1,938	$833	43.0%	$2,771	1.9%	$1,974	$849	$2,823	$0	$2,823	154.0%	$5,014	$2,156	$7,170
08	ROADS, RAILROADS & BRIDGES Contr 08	$5,650	$2,429	43.0%	$8,079	1.9%	$5,756	$2,475	$8,232	$0	$8,232	194.4%	$16,948	$7,288	$24,236
08	ROADS, RAILROADS & BRIDGES Contr 09	$5,162	$2,220	43.0%	$7,382	1.9%	$5,260	$2,262	$7,522	$0	$7,522	221.7%	$16,922	$7,277	$24,199
08	ROADS, RAILROADS & BRIDGES Contr 10	$5,650	$2,429	43.0%	$8,079	1.9%	$5,756	$2,475	$8,232	$0	$8,232	262.1%	$20,844	$8,963	$29,808
08	ROADS, RAILROADS & BRIDGES Contr 11	$84,966	$36,535	43.0%	$121,501	1.9%	$86,572	$37,226	$123,798	$0	$123,798	332.4%	$374,317	$160,956	$535,273
02	RELOCATIONS (Utilities)	$8,750	$3,763	43.0%	$12,513	1.9%	$8,915	$3,834	$12,749	$0	$12,749	32.5%	$11,817	$5,081	$16,899
	#N/A	$0	$0	-	$0	-	$0	$0	$0	$0	$0	-	$0	$0	$0
	#N/A	$0	$0	-	$0	-	$0	$0	$0	$0	$0	-	$0	$0	$0
	CONSTRUCTION ESTIMATE TOTALS:	$258,709	$111,245		$369,954	1.9%	$263,601	$113,348	$376,949	$0	$376,949	156.9%	$677,235	$291,211	$968,446
01	LANDS AND DAMAGES	$0	$0	-	$0	-	$0	$0	$0	$0	$0	-	$0	$0	$0
30	PLANNING, ENGINEERING & DESIGN	$13,789	$5,929	43.0%	$19,719	3.4%	$14,259	$6,131	$20,390	$0	$20,390	259.8%	$51,306	$22,062	$73,368
31	CONSTRUCTION MANAGEMENT	$6,691	$2,877	43.0%	$9,568	3.4%	$6,919	$2,975	$9,894	$0	$9,894	244.8%	$23,854	$10,257	$34,111
	PROJECT COST TOTALS:	$279,189	$120,051	43.0%	$399,241		$284,778	$122,455	**$407,233**	$0	**$407,233**	164.2%	$752,395	$323,530	$1,075,925

ESTIMATED TOTAL PROJECT COST: **$1,075,925**

____________________ **CHIEF, COST ENGINEERING, Christopher Tilley (Acting)**

____________________ **PROJECT MANAGER, Craig Martin**

____________________ **CHIEF, REAL ESTATE, Gaelen Daly**

____________________ **CHIEF, PLANNING, John Kennelly**

____________________ **CHIEF, ENGINEERING, David Margolis**

____________________ **CHIEF, OPERATIONS, Eric Pedersen**

____________________ **CHIEF, CONSTRUCTION, Sean Dolan**

____________________ **CHIEF, CONTRACTING, Sheila Winston-Vincuilla**

____________________ **CHIEF, PM-PB, Janet Harrington**

____________________ **CHIEF, DPM, Scott Acone**

**** TOTAL PROJECT COST SUMMARY ****

**** CONTRACT COST SUMMARY ****

PROJECT: Bourne Bridge Rehabilitation Alternative
LOCATION: Cape Cod Canal, Massachusetts
This Estimate reflects the scope and schedule in report; CCC Bridges Major Rehabilitation Evaluation Report September 2018

DISTRICT: NAE District
POC: CHIEF, COST ENGINEERING, Christopher Tilley (.

PREPARED: 9/11/2019
UPDATED: 2/28/2020

Civil Works Work Breakdown Structure		ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis)				TOTAL PROJECT COST (FULLY FUNDED)				
BOURNE BRIDGE - REHABILITATION		Estimate Prepared:			**11-Sep-19**	Program Year (Budget EC):			2020					
		Effective Price Level:			1-Oct-18	Effective Price Level Date:			1 OCT 19					
				RISK BASED										
WBS NUMBER *A*	Civil Works Feature & Sub-Feature Description *B*	COST ($K) *C*	CNTG ($K) *D*	CNTG (%) *E*	TOTAL ($K) *F*	ESC (%) *G*	COST ($K) *H*	CNTG ($K) *I*	TOTAL ($K) *J*	Mid-Point Date *P*	INFLATED (%) *L*	COST ($K) *M*	CNTG ($K) *N*	FULL ($K) *O*
	01 Contract 01: Major Rehab (29-31)													
08	Truss Span Deck Replacement	$30,163	$12,970	43.0%	$43,134	1.9%	$30,734	$13,215	$43,949	2030Q3	36.5%	$41,959	$18,042	$60,001
08	Suspender Cable Replacement	$10,234	$4,401	43.0%	$14,635	1.9%	$10,428	$4,484	$14,912	2030Q3	36.5%	$14,236	$6,122	$20,358
08	Replace Abutment Spans	$7,841	$3,372	43.0%	$11,213	1.9%	$7,989	$3,435	$11,425	2030Q3	36.5%	$10,907	$4,690	$15,597
08	Bearing Replacement	$3,460	$1,488	43.0%	$4,948	1.9%	$3,525	$1,516	$5,041	2030Q3	36.5%	$4,813	$2,070	$6,882
08	Joint Replacement	$1,938	$833	43.0%	$2,771	1.9%	$1,974	$849	$2,823	2030Q3	36.5%	$2,695	$1,159	$3,854
08	Minor Steel Truss Repairs	$9,190	$3,952	43.0%	$13,142	1.9%	$9,364	$4,026	$13,390	2030Q3	36.5%	$12,784	$5,497	$18,281
08	Major Steel Truss Repairs	$27,904	$11,999	43.0%	$39,903	1.9%	$28,432	$12,226	$40,657	2030Q3	36.5%	$38,816	$16,691	$55,507
08	Paving	$3,225	$1,387	43.0%	$4,611	1.9%	$3,286	$1,413	$4,699	2030Q3	36.5%	$4,486	$1,929	$6,415
08	Complete Painting of Structural Steel	$17,120	$7,362	43.0%	$24,482	1.9%	$17,444	$7,501	$24,945	2030Q3	36.5%	$23,815	$10,240	$34,055
02	RELOCATIONS (Utilities)	$8,750	$3,763	43.0%	$12,513	1.9%	$8,915	$3,834	$12,749	2029Q3	32.5%	$11,817	$5,081	$16,899
	CONSTRUCTION ESTIMATE TOTALS:	$119,825	$51,525	43.0%	**$171,350**		$122,091	$52,499	$174,590			$166,328	$71,521	$237,849
01	LANDS AND DAMAGES	$0	$0	0.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
30	PLANNING, ENGINEERING & DESIGN													
4.6%	Project Management	$5,554	$2,388	43.0%	$7,942	3.4%	$5,743	$2,469	$8,212	2023Q2	13.0%	$6,490	$2,791	$9,281
	Planning & Environmental Compliance	INC.		43.0%		0.0%		$0	$0	0	13.0%	$0	$0	$0
	Engineering & Design	INC.		43.0%		0.0%		$0	$0	0	13.0%	$0	$0	$0
	Reviews, ATRs, IEPRs, VE	INC.		43.0%		0.0%		$0	$0	0	13.0%	$0	$0	$0
	Life Cycle Updates (cost, schedule, risks)	INC.		43.0%		0.0%		$0	$0	0	13.0%	$0	$0	$0
	Contracting & Reprographics	INC.		43.0%		0.0%		$0	$0	0	13.0%	$0	$0	$0
	Engineering During Construction	INC.		43.0%		0.0%		$0	$0	0	48.9%	$0	$0	$0
	Planning During Construction	INC.		43.0%		0.0%		$0	$0	0	48.9%	$0	$0	$0
	Project Operations	INC.		43.0%		0.0%		$0	$0	0	13.0%	$0	$0	$0
31	CONSTRUCTION MANAGEMENT													
1.9%	Construction Management	$2,278	$980	43.0%	$3,258	3.4%	$2,356	$1,013	$3,369	2030Q3	48.9%	$3,508	$1,508	$5,017
	Project Operation:	INC.		43.0%		0.0%		$0	$0	0	48.9%	$0	$0	$0
	Project Management	INC.		43.0%		0.0%		$0	$0	0	48.9%	$0	$0	$0
	CONTRACT COST TOTALS:	$127,657	$54,893		$182,550		$130,190	$55,982	$186,171			$176,326	$75,820	$252,147

**** TOTAL PROJECT COST SUMMARY ****

**** CONTRACT COST SUMMARY ****

PROJECT: Bourne Bridge Rehabilitation Alternative
LOCATION: Cape Cod Canal, Massachusetts
This Estimate reflects the scope and schedule in report; CCC Bridges Major Rehabilitation Evaluation Report September 2018

DISTRICT: NAE District
POC: CHIEF, COST ENGINEERING, Christopher Tilley (.

PREPARED: 9/11/2019
UPDATED: 2/28/2020

Civil Works Work Breakdown Structure		**ESTIMATED COST**				**PROJECT FIRST COST (Constant Dollar Basis)**				**TOTAL PROJECT COST (FULLY FUNDED)**				
BOURNE BRIDGE - REHABILITATION		Estimate Prepared:			**11-Sep-19**	Program Year (Budget EC):			2020					
		Effective Price Level:			1-Oct-18	Effective Price Level Date:			1 OCT 19					
WBS NUMBER *A*	Civil Works Feature & Sub-Feature Description *B*	COST ($K) *C*	CNTG ($K) *D*	CNTG (%) *E*	TOTAL ($K) *F*	ESC (%) *G*	COST ($K) *H*	CNTG ($K) *I*	TOTAL ($K) *J*	Mid-Point Date *P*	INFLATED (%) *L*	COST ($K) *M*	CNTG ($K) *N*	FULL ($K) *O*
	02 Contract 02: Maint Paint (36)													
08	Maintenance Painting of Structural Steel	$5,650	$2,429	43.0%	$8,079	1.9%	$5,756	$2,475	$8,232	2036Q3	63.0%	$9,384	$4,035	$13,419
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	CONSTRUCTION ESTIMATE TOTALS:	$5,650	$2,429	43.0%	**$8,079**		$5,756	$2,475	$8,232			$9,384	$4,035	$13,419
01	LANDS AND DAMAGES	$0	$0	0.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
30	PLANNING, ENGINEERING & DESIGN													
5.0%	Project Management	$282	$121	43.0%	$404	3.4%	$292	$126	$418	2035Q2	79.7%	$525	$226	$751
	Planning & Environmental Compliance	INC.		43.0%		0.0%		$0	$0	0	79.7%	$0	$0	$0
	Engineering & Design	INC.		43.0%		0.0%		$0	$0	0	79.7%	$0	$0	$0
	Reviews, ATRs, IEPRs, VE	INC.		43.0%		0.0%		$0	$0	0	79.7%	$0	$0	$0
	Life Cycle Updates (cost, schedule, risks)	INC.		43.0%		0.0%		$0	$0	0	79.7%	$0	$0	$0
	Contracting & Reprographics	INC.		43.0%		0.0%		$0	$0	0	79.7%	$0	$0	$0
	Engineering During Construction	INC.		43.0%		0.0%		$0	$0	0	89.0%	$0	$0	$0
	Planning During Construction	INC.		43.0%		0.0%		$0	$0	0	89.0%	$0	$0	$0
	Project Operations	INC.		43.0%		0.0%		$0	$0	0	79.7%	$0	$0	$0
31	CONSTRUCTION MANAGEMENT													
4.6%	Construction Management	$261	$112	43.0%	$374	3.4%	$270	$116	$386	2036Q3	89.0%	$511	$220	$730
	Project Operation:	INC.		43.0%		0.0%		$0	$0	0	89.0%	$0	$0	$0
	Project Management	INC.		43.0%		0.0%		$0	$0	0	89.0%	$0	$0	$0
	CONTRACT COST TOTALS:	$6,193	$2,663		$8,857		$6,319	$2,717	$9,036			$10,420	$4,480	$14,900

**** TOTAL PROJECT COST SUMMARY ****

**** CONTRACT COST SUMMARY ****

PROJECT: Bourne Bridge Rehabilitation Alternative
LOCATION: Cape Cod Canal, Massachusetts
This Estimate reflects the scope and schedule in report; CCC Bridges Major Rehabilitation Evaluation Report September 2018

DISTRICT: NAE District
POC: CHIEF, COST ENGINEERING, Christopher Tilley (.

PREPARED: 9/11/2019
UPDATED: 2/28/2020

Civil Works Work Breakdown Structure		**ESTIMATED COST**				**PROJECT FIRST COST (Constant Dollar Basis)**				**TOTAL PROJECT COST (FULLY FUNDED)**				
BOURNE BRIDGE - REHABILITATION		Estimate Prepared: Effective Price Level:			**11-Sep-19** 1-Oct-18	Program Year (Budget EC): Effective Price Level Date:			2020 1 OCT 19					
WBS NUMBER *A*	Civil Works Feature & Sub-Feature Description *B*	COST ($K) *C*	CNTG ($K) *D*	CNTG (%) *E*	TOTAL ($K) *F*	ESC (%) *G*	COST ($K) *H*	CNTG ($K) *I*	TOTAL ($K) *J*	Mid-Point Date *P*	INFLATED (%) *L*	COST ($K) *M*	CNTG ($K) *N*	FULL ($K) *O*
	03 Contract 03: Joint Replace (37)													
08	Joint Replacement	$1,938	$833	43.0%	$2,771	1.9%	$1,974	$849	$2,823	2037Q3	67.9%	$3,315	$1,425	$4,740
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	CONSTRUCTION ESTIMATE TOTALS:	$1,938	$833	43.0%	**$2,771**		$1,974	$849	$2,823			$3,315	$1,425	$4,740
01	LANDS AND DAMAGES	$0	$0	0.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
30	PLANNING, ENGINEERING & DESIGN													
15.0%	Project Management	$291	$125	43.0%	$416	3.4%	$301	$129	$430	2036Q2	87.1%	$562	$242	$804
	Planning & Environmental Compliance	INC.		43.0%		0.0%		$0	$0	0	87.1%	$0	$0	$0
	Engineering & Design	INC.		43.0%		0.0%		$0	$0	0	87.1%	$0	$0	$0
	Reviews, ATRs, IEPRs, VE	INC.		43.0%		0.0%		$0	$0	0	87.1%	$0	$0	$0
	Life Cycle Updates (cost, schedule, risks)	INC.		43.0%		0.0%		$0	$0	0	87.1%	$0	$0	$0
	Contracting & Reprographics	INC.		43.0%		0.0%		$0	$0	0	87.1%	$0	$0	$0
	Engineering During Construction	INC.		43.0%		0.0%		$0	$0	0	96.8%	$0	$0	$0
	Planning During Construction	INC.		43.0%		0.0%		$0	$0	0	96.8%	$0	$0	$0
	Project Operations	INC.		43.0%		0.0%		$0	$0	0	87.1%	$0	$0	$0
31	CONSTRUCTION MANAGEMENT													
19.3%	Construction Management	$375	$161	43.0%	$536	3.4%	$387	$167	$554	2037Q3	96.8%	$762	$328	$1,090
	Project Operation:	INC.		43.0%		0.0%		$0	$0	0	96.8%	$0	$0	$0
	Project Management	INC.		43.0%		0.0%		$0	$0	0	96.8%	$0	$0	$0
	CONTRACT COST TOTALS:	$2,603	$1,119		**$3,722**		$2,662	$1,145	$3,807			$4,639	$1,995	**$6,634**

**** TOTAL PROJECT COST SUMMARY ****

**** CONTRACT COST SUMMARY ****

PROJECT: Bourne Bridge Rehabilitation Alternative
LOCATION: Cape Cod Canal, Massachusetts
This Estimate reflects the scope and schedule in report; CCC Bridges Major Rehabilitation Evaluation Report September 2018

DISTRICT: NAE District
POC: CHIEF, COST ENGINEERING, Christopher Tilley (.
PREPARED: 9/11/2019
UPDATED: 2/28/2020

Civil Works Work Breakdown Structure		**ESTIMATED COST**				**PROJECT FIRST COST (Constant Dollar Basis)**				**TOTAL PROJECT COST (FULLY FUNDED)**				
BOURNE BRIDGE - REHABILITATION		Estimate Prepared:			**11-Sep-19**	Program Year (Budget EC):			2020	FULLY FUNDED PROJECT ESTIMATE				
		Effective Price Level:			1-Oct-18	Effective Price Level Date:			1 OCT 19					
WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Mid-Point Date	INFLATED (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*	*P*	*L*	*M*	*N*	*O*
	04 Contract 04: Maint Paint (43)													
08	Maintenance Painting of Structural Steel	$5,650	$2,429	43.0%	$8,079	1.9%	$5,756	$2,475	$8,232	2043Q3	100.5%	$11,541	$4,963	$16,504
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	CONSTRUCTION ESTIMATE TOTALS:	$5,650	$2,429	43.0%	**$8,079**		$5,756	$2,475	$8,232			$11,541	$4,963	$16,504
01	LANDS AND DAMAGES	$0	$0	0.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
30	PLANNING, ENGINEERING & DESIGN													
5.0%	Project Management	$282	$121	43.0%	$404	3.4%	$292	$126	$418	2042Q2	139.2%	$699	$300	$999
	Planning & Environmental Compliance	INC.		43.0%		0.0%		$0	$0	0	139.2%	$0	$0	$0
	Engineering & Design	INC.		43.0%		0.0%		$0	$0	0	139.2%	$0	$0	$0
	Reviews, ATRs, IEPRs, VE	INC.		43.0%		0.0%		$0	$0	0	139.2%	$0	$0	$0
	Life Cycle Updates (cost, schedule, risks)	INC.		43.0%		0.0%		$0	$0	0	139.2%	$0	$0	$0
	Contracting & Reprographics	INC.		43.0%		0.0%		$0	$0	0	139.2%	$0	$0	$0
	Engineering During Construction	INC.		43.0%		0.0%		$0	$0	0	151.9%	$0	$0	$0
	Planning During Construction	INC.		43.0%		0.0%		$0	$0	0	151.9%	$0	$0	$0
	Project Operations	INC.		43.0%		0.0%		$0	$0	0	139.2%	$0	$0	$0
31	CONSTRUCTION MANAGEMENT													
4.6%	Construction Management	$261	$112	43.0%	$374	3.4%	$270	$116	$386	2043Q3	151.9%	$681	$293	$973
	Project Operation:	INC.		43.0%		0.0%		$0	$0	0	151.9%	$0	$0	$0
	Project Management	INC.		43.0%		0.0%		$0	$0	0	151.9%	$0	$0	$0
	CONTRACT COST TOTALS:	$6,193	$2,663		**$8,857**		$6,319	$2,717	$9,036			$12,920	$5,556	**$18,476**

**** TOTAL PROJECT COST SUMMARY ****

**** CONTRACT COST SUMMARY ****

PROJECT: Bourne Bridge Rehabilitation Alternative
LOCATION: Cape Cod Canal, Massachusetts
This Estimate reflects the scope and schedule in report; CCC Bridges Major Rehabilitation Evaluation Report September 2018

DISTRICT: NAE District
POC: CHIEF, COST ENGINEERING, Christopher Tilley (.
PREPARED: 9/11/2019
UPDATED: 2/28/2020

Civil Works Work Breakdown Structure		**ESTIMATED COST**				**PROJECT FIRST COST (Constant Dollar Basis)**				**TOTAL PROJECT COST (FULLY FUNDED)**				
BOURNE BRIDGE - REHABILITATION		Estimate Prepared: Effective Price Level:			**11-Sep-19** 1-Oct-18	Program Year (Budget EC): Effective Price Level Date:			2020 1 OCT 19	FULLY FUNDED PROJECT ESTIMATE				
WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Mid-Point Date	INFLATED (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*	*P*	*L*	*M*	*N*	*O*
	05 Contract 05: Paving & Joint Replace (44)													
08	Paving	$3,225	$1,387	43.0%	$4,611	1.9%	$3,286	$1,413	$4,699	2044Q3	106.5%	$6,785	$2,918	$9,703
08	Joint Replacement	$1,938	$833	43.0%	$2,771	1.9%	$1,974	$849	$2,823	2044Q3	106.5%	$4,077	$1,753	$5,830
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	CONSTRUCTION ESTIMATE TOTALS:	$5,162	$2,220	43.0%	**$7,382**		$5,260	$2,262	$7,522			$10,862	$4,671	$15,532
01	LANDS AND DAMAGES	$0	$0	0.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
30	PLANNING, ENGINEERING & DESIGN													
11.9%	Project Management	$613	$264	43.0%	$877	3.4%	$634	$273	$907	2043Q2	149.3%	$1,580	$680	$2,260
	Planning & Environmental Compliance	INC.		43.0%		0.0%		$0	$0	0	149.3%	$0	$0	$0
	Engineering & Design	INC.		43.0%		0.0%		$0	$0	0	149.3%	$0	$0	$0
	Reviews, ATRs, IEPRs, VE	INC.		43.0%		0.0%		$0	$0	0	149.3%	$0	$0	$0
	Life Cycle Updates (cost, schedule, risks)	INC.		43.0%		0.0%		$0	$0	0	149.3%	$0	$0	$0
	Contracting & Reprographics	INC.		43.0%		0.0%		$0	$0	0	149.3%	$0	$0	$0
	Engineering During Construction	INC.		43.0%		0.0%		$0	$0	0	162.5%	$0	$0	$0
	Planning During Construction	INC.		43.0%		0.0%		$0	$0	0	162.5%	$0	$0	$0
	Project Operations	INC.		43.0%		0.0%		$0	$0	0	149.3%	$0	$0	$0
31	CONSTRUCTION MANAGEMENT													
9.8%	Construction Management	$508	$218	43.0%	$726	3.4%	$525	$226	$751	2044Q3	162.5%	$1,378	$593	$1,971
	Project Operation:	INC.		43.0%		0.0%		$0	$0	0	162.5%	$0	$0	$0
	Project Management	INC.		43.0%		0.0%		$0	$0	0	162.5%	$0	$0	$0
	CONTRACT COST TOTALS:	$6,283	$2,702		**$8,985**		$6,419	$2,760	$9,179			$13,821	$5,943	**$19,763**

**** TOTAL PROJECT COST SUMMARY ****

**** CONTRACT COST SUMMARY ****

PROJECT: Bourne Bridge Rehabilitation Alternative
LOCATION: Cape Cod Canal, Massachusetts
This Estimate reflects the scope and schedule in report; CCC Bridges Major Rehabilitation Evaluation Report September 2018

DISTRICT: NAE District
POC: CHIEF, COST ENGINEERING, Christopher Tilley (.

PREPARED: 9/11/2019
UPDATED: 2/28/2020

Civil Works Work Breakdown Structure		**ESTIMATED COST**				**PROJECT FIRST COST (Constant Dollar Basis)**				**TOTAL PROJECT COST (FULLY FUNDED)**				
BOURNE BRIDGE - REHABILITATION		Estimate Prepared:			**11-Sep-19**	Program Year (Budget EC):			2020	FULLY FUNDED PROJECT ESTIMATE				
		Effective Price Level:			1-Oct-18	Effective Price Level Date:			1 OCT 19					
WBS NUMBER ***A***	Civil Works Feature & Sub-Feature Description ***B***	COST ($K) ***C***	CNTG ($K) ***D***	CNTG (%) ***E***	TOTAL ($K) ***F***	ESC (%) ***G***	COST ($K) ***H***	CNTG ($K) ***I***	TOTAL ($K) ***J***	Mid-Point Date ***P***	INFLATED (%) ***L***	COST ($K) ***M***	CNTG ($K) ***N***	FULL ($K) ***O***
	06 Contract 06: Complete Paint (49)													
08	Complete Painting of Structural Steel	$17,120	$7,362	43.0%	$24,482	1.9%	$17,444	$7,501	$24,945	2049Q3	139.4%	$41,760	$17,957	$59,716
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	CONSTRUCTION ESTIMATE TOTALS:	$17,120	$7,362	43.0%	**$24,482**		$17,444	$7,501	$24,945			$41,760	$17,957	$59,716
01	LANDS AND DAMAGES	$0	$0	0.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
30	PLANNING, ENGINEERING & DESIGN													
5.0%	Project Management	$856	$368	43.0%	$1,224	3.4%	$885	$381	$1,266	2048Q2	206.2%	$2,711	$1,166	$3,876
	Planning & Environmental Compliance	INC.		43.0%		0.0%		$0	$0	0	206.2%	$0	$0	$0
	Engineering & Design	INC.		43.0%		0.0%		$0	$0	0	206.2%	$0	$0	$0
	Reviews, ATRs, IEPRs, VE	INC.		43.0%		0.0%		$0	$0	0	206.2%	$0	$0	$0
	Life Cycle Updates (cost, schedule, risks)	INC.		43.0%		0.0%		$0	$0	0	206.2%	$0	$0	$0
	Contracting & Reprographics	INC.		43.0%		0.0%		$0	$0	0	206.2%	$0	$0	$0
	Engineering During Construction	INC.		43.0%		0.0%		$0	$0	0	222.4%	$0	$0	$0
	Planning During Construction	INC.		43.0%		0.0%		$0	$0	0	222.4%	$0	$0	$0
	Project Operations	INC.		43.0%		0.0%		$0	$0	0	206.2%	$0	$0	$0
31	CONSTRUCTION MANAGEMENT													
2.4%	Construction Management	$417	$179	43.0%	$596	3.4%	$431	$185	$617	2049Q3	222.4%	$1,391	$598	$1,988
	Project Operation:	INC.		43.0%		0.0%		$0	$0	0	222.4%	$0	$0	$0
	Project Management	INC.		43.0%		0.0%		$0	$0	0	222.4%	$0	$0	$0
	CONTRACT COST TOTALS:	$18,393	$7,909		**$26,302**		$18,760	$8,067	$26,827			$45,861	$19,720	**$65,581**

**** TOTAL PROJECT COST SUMMARY ****

**** CONTRACT COST SUMMARY ****

PROJECT: Bourne Bridge Rehabilitation Alternative
LOCATION: Cape Cod Canal, Massachusetts
This Estimate reflects the scope and schedule in report; CCC Bridges Major Rehabilitation Evaluation Report September 2018

DISTRICT: NAE District
POC: CHIEF, COST ENGINEERING, Christopher Tilley (.

PREPARED: 9/11/2019
UPDATED: 2/28/2020

Civil Works Work Breakdown Structure		ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis)				TOTAL PROJECT COST (FULLY FUNDED)				
BOURNE BRIDGE - REHABILITATION		Estimate Prepared: Effective Price Level:			**11-Sep-19** 1-Oct-18	Program Year (Budget EC): Effective Price Level Date:			2020 1 OCT 19	FULLY FUNDED PROJECT ESTIMATE				
WBS NUMBER *A*	Civil Works Feature & Sub-Feature Description *B*	COST ($K) *C*	CNTG ($K) *D*	CNTG (%) *E*	TOTAL ($K) *F*	ESC (%) *G*	COST ($K) *H*	CNTG ($K) *I*	TOTAL ($K) *J*	Mid-Point Date *P*	INFLATED (%) *L*	COST ($K) *M*	CNTG ($K) *N*	FULL ($K) *O*
	07 Contract 07: Joint Replace (51)													
08	Joint Replacement	$1,938	$833	43.0%	$2,771	1.9%	$1,974	$849	$2,823	2051Q3	154.0%	$5,014	$2,156	$7,170
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	CONSTRUCTION ESTIMATE TOTALS:	$1,938	$833	43.0%	**$2,771**		$1,974	$849	$2,823			$5,014	$2,156	$7,170
01	LANDS AND DAMAGES	$0	$0	0.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
30	PLANNING, ENGINEERING & DESIGN													
15.0%	Project Management	$291	$125	43.0%	$416	3.4%	$301	$129	$430	2050Q2	232.5%	$999	$430	$1,429
	Planning & Environmental Compliance	INC.		43.0%		0.0%		$0	$0	0	232.5%	$0	$0	$0
	Engineering & Design	INC.		43.0%		0.0%		$0	$0	0	232.5%	$0	$0	$0
	Reviews, ATRs, IEPRs, VE	INC.		43.0%		0.0%		$0	$0	0	232.5%	$0	$0	$0
	Life Cycle Updates (cost, schedule, risks)	INC.		43.0%		0.0%		$0	$0	0	232.5%	$0	$0	$0
	Contracting & Reprographics	INC.		43.0%		0.0%		$0	$0	0	232.5%	$0	$0	$0
	Engineering During Construction	INC.		43.0%		0.0%		$0	$0	0	250.1%	$0	$0	$0
	Planning During Construction	INC.		43.0%		0.0%		$0	$0	0	250.1%	$0	$0	$0
	Project Operations	INC.		43.0%		0.0%		$0	$0	0	232.5%	$0	$0	$0
31	CONSTRUCTION MANAGEMENT													
19.3%	Construction Management	$375	$161	43.0%	$536	3.4%	$387	$167	$554	2051Q3	250.1%	$1,356	$583	$1,939
	Project Operation:	INC.		43.0%		0.0%		$0	$0	0	250.1%	$0	$0	$0
	Project Management	INC.		43.0%		0.0%		$0	$0	0	250.1%	$0	$0	$0
	CONTRACT COST TOTALS:	$2,603	$1,119		**$3,722**		$2,662	$1,145	$3,807			$7,369	$3,169	**$10,538**

**** TOTAL PROJECT COST SUMMARY ****

**** CONTRACT COST SUMMARY ****

PROJECT: Bourne Bridge Rehabilitation Alternative
LOCATION: Cape Cod Canal, Massachusetts
This Estimate reflects the scope and schedule in report; CCC Bridges Major Rehabilitation Evaluation Report September 2018

DISTRICT: NAE District
POC: CHIEF, COST ENGINEERING, Christopher Tilley (.
PREPARED: 9/11/2019
UPDATED: 2/28/2020

Civil Works Work Breakdown Structure		ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis)				TOTAL PROJECT COST (FULLY FUNDED)				
BOURNE BRIDGE - REHABILITATION		Estimate Prepared: Effective Price Level:			**11-Sep-19** 1-Oct-18	Program Year (Budget EC): Effective Price Level Date:			2020 1 OCT 19	FULLY FUNDED PROJECT ESTIMATE				
WBS NUMBER **A**	Civil Works Feature & Sub-Feature Description **B**	COST ($K) **C**	CNTG ($K) **D**	CNTG (%) **E**	TOTAL ($K) **F**	ESC (%) **G**	COST ($K) **H**	CNTG ($K) **I**	TOTAL ($K) **J**	Mid-Point Date **P**	INFLATED (%) **L**	COST ($K) **M**	CNTG ($K) **N**	FULL ($K) **O**
	08 Contract 08: Maint Paint (56)													
08	Maintenance Painting of Structural Steel	$5,650	$2,429	43.0%	$8,079	1.9%	$5,756	$2,475	$8,232	2056Q3	194.4%	$16,948	$7,288	$24,236
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	CONSTRUCTION ESTIMATE TOTALS:	$5,650	$2,429	43.0%	**$8,079**		$5,756	$2,475	$8,232			$16,948	$7,288	$24,236
01	LANDS AND DAMAGES	$0	$0	0.0%	$ -	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
30	PLANNING, ENGINEERING & DESIGN													
5.0%	Project Management	$282	$121	43.0%	$404	3.4%	$292	$126	$418	2055Q2	308.4%	$1,193	$513	$1,706
	Planning & Environmental Compliance	INC.		43.0%		0.0%		$0	$0	0	308.4%	$0	$0	$0
	Engineering & Design	INC.		43.0%		0.0%		$0	$0	0	308.4%	$0	$0	$0
	Reviews, ATRs, IEPRs, VE	INC.		43.0%		0.0%		$0	$0	0	308.4%	$0	$0	$0
	Life Cycle Updates (cost, schedule, risks)	INC.		43.0%		0.0%		$0	$0	0	308.4%	$0	$0	$0
	Contracting & Reprographics	INC.		43.0%		0.0%		$0	$0	0	308.4%	$0	$0	$0
	Engineering During Construction	INC.		43.0%		0.0%		$0	$0	0	330.0%	$0	$0	$0
	Planning During Construction	INC.		43.0%		0.0%		$0	$0	0	330.0%	$0	$0	$0
	Project Operations	INC.		43.0%		0.0%		$0	$0	0	308.4%	$0	$0	$0
31	CONSTRUCTION MANAGEMENT													
4.6%	Construction Management	$261	$112	43.0%	374	3.4%	$270	$116	$386	2056Q3	330.0%	$1,162	$500	$1,661
	Project Operation:	INC.		43.0%		0.0%		$0	$0	0	330.0%	$0	$0	$0
	Project Management	INC.		43.0%		0.0%		$0	$0	0	330.0%	$0	$0	$0
	CONTRACT COST TOTALS:	$6,193	$2,663		**8,857**		$6,319	$2,717	$9,036			$19,303	$8,300	**$27,604**

**** TOTAL PROJECT COST SUMMARY ****

**** CONTRACT COST SUMMARY ****

PROJECT: Bourne Bridge Rehabilitation Alternative
LOCATION: Cape Cod Canal, Massachusetts
This Estimate reflects the scope and schedule in report; CCC Bridges Major Rehabilitation Evaluation Report September 2018

DISTRICT: NAE District
POC: CHIEF, COST ENGINEERING, Christopher Tilley (

PREPARED: 9/11/2019
UPDATED: 2/28/2020

Civil Works Work Breakdown Structure		**ESTIMATED COST**				**PROJECT FIRST COST (Constant Dollar Basis)**				**TOTAL PROJECT COST (FULLY FUNDED)**				
BOURNE BRIDGE - REHABILITATION		Estimate Prepared:			**11-Sep-19**	Program Year (Budget EC):			2020	FULLY FUNDED PROJECT ESTIMATE				
		Effective Price Level:			1-Oct-18	Effective Price Level Date:		1	OCT 19					
WBS NUMBER *A*	Civil Works Feature & Sub-Feature Description *B*	COST ($K) *C*	CNTG ($K) *D*	CNTG (%) *E*	TOTAL ($K) *F*	ESC (%) *G*	COST ($K) *H*	CNTG ($K) *I*	TOTAL ($K) *J*	Mid-Point Date *P*	INFLATED (%) *L*	COST ($K) *M*	CNTG ($K) *N*	FULL ($K) *O*
	09 Contract 09: Paving & Joint Replace (59)													
08	Paving	$3,225	$1,387	43.0%	$4,611	1.9%	$3,286	$1,413	$4,699	2059Q3	221.7%	$10,571	$4,546	$15,117
08	Joint Replacement	$1,938	$833	43.0%	$2,771	1.9%	$1,974	$849	$2,823	2059Q3	221.7%	$6,351	$2,731	$9,082
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	CONSTRUCTION ESTIMATE TOTALS:	$5,162	$2,220	43.0%	**$7,382**		$5,260	$2,262	$7,522			$16,922	$7,277	$24,199
01	LANDS AND DAMAGES	$0	$0	0.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
30	PLANNING, ENGINEERING & DESIGN													
11.9%	Project Management	$613	$264	43.0%	$877	3.4%	$634	$273	$907	2058Q2	362.1%	$2,929	$1,260	$4,189
	Planning & Environmental Compliance	INC.		43.0%		0.0%		$0	$0	0	362.1%	$0	$0	$0
	Engineering & Design	INC.		43.0%		0.0%		$0	$0	0	362.1%	$0	$0	$0
	Reviews, ATRs, IEPRs, VE	INC.		43.0%		0.0%		$0	$0	0	362.1%	$0	$0	$0
	Life Cycle Updates (cost, schedule, risks)	INC.		43.0%		0.0%		$0	$0	0	362.1%	$0	$0	$0
	Contracting & Reprographics	INC.		43.0%		0.0%		$0	$0	0	362.1%	$0	$0	$0
	Engineering During Construction	INC.		43.0%		0.0%		$0	$0	0	386.5%	$0	$0	$0
	Planning During Construction	INC.		43.0%		0.0%		$0	$0	0	386.5%	$0	$0	$0
	Project Operations	INC.		43.0%		0.0%		$0	$0	0	362.1%	$0	$0	$0
31	CONSTRUCTION MANAGEMENT													
9.8%	Construction Management	$508	$218	43.0%	$726	3.4%	$525	$226	$751	2059Q3	386.5%	$2,555	$1,099	$3,653
	Project Operation:	INC.		43.0%		0.0%		$0	$0	0	386.5%	$0	$0	$0
	Project Management	INC.		43.0%		0.0%		$0	$0	0	386.5%	$0	$0	$0
	CONTRACT COST TOTALS:	$6,283	$2,702		**$8,985**		$6,419	$2,760	$9,179			$22,407	$9,635	**$32,041**

**** TOTAL PROJECT COST SUMMARY ****

**** CONTRACT COST SUMMARY ****

PROJECT: Bourne Bridge Rehabilitation Alternative
LOCATION: Cape Cod Canal, Massachusetts
This Estimate reflects the scope and schedule in report; CCC Bridges Major Rehabilitation Evaluation Report September 2018

DISTRICT: NAE District
POC: CHIEF, COST ENGINEERING, Christopher Tilley (.
PREPARED: 9/11/2019
UPDATED: 2/28/2020

Civil Works Work Breakdown Structure		**ESTIMATED COST**				**PROJECT FIRST COST (Constant Dollar Basis)**				**TOTAL PROJECT COST (FULLY FUNDED)**				
BOURNE BRIDGE - REHABILITATION		Estimate Prepared:			**11-Sep-19**	Program Year (Budget EC):			2020	FULLY FUNDED PROJECT ESTIMATE				
		Effective Price Level:			1-Oct-18	Effective Price Level Date:		1	OCT 19					
WBS NUMBER **A**	Civil Works Feature & Sub-Feature Description **B**	COST ($K) **C**	CNTG ($K) **D**	CNTG (%) **E**	TOTAL ($K) **F**	ESC (%) **G**	COST ($K) **H**	CNTG ($K) **I**	TOTAL ($K) **J**	Mid-Point Date **P**	INFLATED (%) **L**	COST ($K) **M**	CNTG ($K) **N**	FULL ($K) **O**
	10 Contract 10: Maint Paint (63)													
08	Maintenance Painting of Structural Steel	$5,650	$2,429	43.0%	$8,079	1.9%	$5,756	$2,475	$8,232	2063Q3	262.1%	$20,844	$8,963	$29,808
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	CONSTRUCTION ESTIMATE TOTALS:	$5,650	$2,429	43.0%	**$8,079**		$5,756	$2,475	$8,232			$20,844	$8,963	$29,808
01	LANDS AND DAMAGES	$0	$0	0.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
30	PLANNING, ENGINEERING & DESIGN													
5.0%	Project Management	$282	$121	43.0%	$404	3.4%	$292	$126	$418	2062Q2	444.7%	$1,591	$684	$2,275
	Planning & Environmental Compliance	INC.		43.0%		0.0%		$0	$0	0	444.7%	$0	$0	$0
	Engineering & Design	INC.		43.0%		0.0%		$0	$0	0	444.7%	$0	$0	$0
	Reviews, ATRs, IEPRs, VE	INC.		43.0%		0.0%		$0	$0	0	444.7%	$0	$0	$0
	Life Cycle Updates (cost, schedule, risks)	INC.		43.0%		0.0%		$0	$0	0	444.7%	$0	$0	$0
	Contracting & Reprographics	INC.		43.0%		0.0%		$0	$0	0	444.7%	$0	$0	$0
	Engineering During Construction	INC.		43.0%		0.0%		$0	$0	0	473.6%	$0	$0	$0
	Planning During Construction	INC.		43.0%		0.0%		$0	$0	0	473.6%	$0	$0	$0
	Project Operations	INC.		43.0%		0.0%		$0	$0	0	444.7%	$0	$0	$0
31	CONSTRUCTION MANAGEMENT													
4.6%	Construction Management	$261	$112	43.0%	$374	3.4%	$270	$116	$386	2063Q3	473.6%	$1,550	$666	$2,216
	Project Operation:	INC.		43.0%		0.0%		$0	$0	0	473.6%	$0	$0	$0
	Project Management	INC.		43.0%		0.0%		$0	$0	0	473.6%	$0	$0	$0
	CONTRACT COST TOTALS:	$6,193	$2,663		**$8,857**		$6,319	$2,717	$9,036			$23,985	$10,314	**$34,299**

**** TOTAL PROJECT COST SUMMARY ****

**** CONTRACT COST SUMMARY ****

PROJECT: Bourne Bridge Rehabilitation Alternative
LOCATION: Cape Cod Canal, Massachusetts
This Estimate reflects the scope and schedule in report; CCC Bridges Major Rehabilitation Evaluation Report September 2018

DISTRICT: NAE District
POC: CHIEF, COST ENGINEERING, Christopher Tilley (.

PREPARED: 9/11/2019
UPDATED: 2/28/2020

BOURNE BRIDGE - REHABILITATION

Estimate Prepared: **11-Sep-19**
Effective Price Level: 1-Oct-18

Program Year (Budget EC): 2020
Effective Price Level Date: 1 OCT 19

Civil Works Work Breakdown Structure		ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis)				TOTAL PROJECT COST (FULLY FUNDED)				
WBS NUMBER *A*	Civil Works Feature & Sub-Feature Description *B*	COST ($K) *C*	CNTG ($K) *D*	CNTG (%) *E*	TOTAL ($K) *F*	ESC (%) *G*	COST ($K) *H*	CNTG ($K) *I*	TOTAL ($K) *J*	Mid-Point Date *P*	INFLATED (%) *L*	COST ($K) *M*	CNTG ($K) *N*	FULL ($K) *O*
	11 Contract 11: Truss Deck, Floorbeam, Major Steel, Complete Paint & Joint Replace (69)													
08	Truss Span Deck Replacement	$30,163	$12,970	43.0%	$43,134	1.9%	$30,734	$13,215	$43,949	2069Q3	332.4%	$132,884	$57,140	$190,024
08	Replace Abutment Spans	$7,841	$3,372	43.0%	$11,213	1.9%	$7,989	$3,435	$11,425	2069Q3	332.4%	$34,544	$14,854	$49,398
08	Major Steel Truss Repairs	$27,904	$11,999	43.0%	$39,903	1.9%	$28,432	$12,226	$40,657	2069Q3	332.4%	$122,931	$52,860	$175,791
08	Complete Painting of Structural Steel	$17,120	$7,362	43.0%	$24,482	1.9%	$17,444	$7,501	$24,945	2069Q3	332.4%	$75,422	$32,432	$107,854
08	Joint Replacement	$1,938	$833	43.0%	$2,771	1.9%	$1,974	$849	$2,823	2069Q3	332.4%	$8,536	$3,670	$12,206
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	CONSTRUCTION ESTIMATE TOTALS:	$84,966	$36,535	43.0%	**$121,501**		$86,572	$37,226	$123,798			$374,317	$160,956	$535,273
01	LANDS AND DAMAGES	$0	$0	0.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
30	PLANNING, ENGINEERING & DESIGN													
5.2%	Project Management	$4,442	$1,910	43.0%	$6,352	3.4%	$4,593	$1,975	$6,569	2068Q2	597.2%	$32,027	$13,771	$45,798
	Planning & Environmental Compliance	INC.		43.0%		0.0%		$0	$0	0	597.2%	$0	$0	$0
	Engineering & Design	INC.		43.0%		0.0%		$0	$0	0	597.2%	$0	$0	$0
	Reviews, ATRs, IEPRs, VE	INC.		43.0%		0.0%		$0	$0	0	597.2%	$0	$0	$0
	Life Cycle Updates (cost, schedule, risks)	INC.		43.0%		0.0%		$0	$0	0	597.2%	$0	$0	$0
	Contracting & Reprographics	INC.		43.0%		0.0%		$0	$0	0	597.2%	$0	$0	$0
	Engineering During Construction	INC.		43.0%		0.0%		$0	$0	0	634.1%	$0	$0	$0
	Planning During Construction	INC.		43.0%		0.0%		$0	$0	0	634.1%	$0	$0	$0
	Project Operations	INC.		43.0%		0.0%		$0	$0	0	597.2%	$0	$0	$0
31	CONSTRUCTION MANAGEMENT													
1.4%	Construction Management	$1,186	$510	43.0%	$1,695	3.4%	$1,226	$527	$1,753	2069Q3	634.1%	$9,001	$3,870	$12,871
	Project Operation:	INC.		43.0%		0.0%		$0	$0	0	634.1%	$0	$0	$0
	Project Management	INC.		43.0%		0.0%		$0	$0	0	634.1%	$0	$0	$0
	CONTRACT COST TOTALS:	$90,594	$38,955		$129,549		$92,392	$39,728	$132,120			$415,345	$178,598	$593,943

**** TOTAL PROJECT COST SUMMARY ****

PROJECT: **Bridge Replacement Alternative - 4 Lane Bridge with Auxiliary On/Off Lanes**
PROJECT NO: P2# 450095
LOCATION: Cape Cod Canal, Massachusetts

DISTRICT: NAE District **PREPARED: 10/2/2018**
POC: CHIEF, COST ENGINEERING, Christopher Tilley (Acting)
UPDATED: 2/28/2020

This Estimate reflects the scope and schedule in report; CCC Bridges Major Rehabilitation Evaluation Report September 2018

Civil Works Work Breakdown Structure		**ESTIMATED COST**				**PROJECT FIRST COST (Constant Dollar Basis)**						**TOTAL PROJECT COST (FULLY FUNDED)**			
BOURNE AND SAGAMORE BRIDGE - REPLACEMENT (4 LANES WITH AUXILIARY ON/OFF LANES)						Program Year (Budget EC): 2020 Effective Price Level Date: 1 OCT 19									
WBS NUMBER *A*	Civil Works Feature & Sub-Feature Description *B*	COST ($K) *C*	CNTG ($K) *D*	CNTG (%) *E*	TOTAL ($K) *F*	ESC (%) *G*	COST ($K) *H*	CNTG ($K) *I*	**TOTAL ($K)** *J*	Spent Thru: **1-Oct-19** ($K)	**TOTAL FIRST COST** ($K) *K*	INFLATED (%) *L*	COST ($K) *M*	CNTG ($K) *N*	FULL ($K) *O*
08	ROADS, RAILROADS & BRIDGES Replacem	$588,108	$258,768	44.0%	$846,876	0.0%	$588,108	$258,768	$846,876	$0	$846,876	37.0%	$805,512	$354,425	$1,159,938
08	ROADS, RAILROADS & BRIDGES Approach	$88,153	$38,787	44.0%	$126,940	0.0%	$88,153	$38,787	$126,940	$0	$126,940	37.0%	$120,793	$53,149	$173,942
08	ROADS, RAILROADS & BRIDGES Major Rep	$12,672	$5,576	44.0%	$18,248	0.0%	$12,672	$5,576	$18,248	$0	$18,248	216.4%	$40,100	$17,644	$57,743
02	RELOCATIONS (Utilities)	$39,000	$17,160	44.0%	$56,160	0.0%	$39,000	$17,160	$56,160	$0	$56,160	26.7%	$49,399	$21,736	$71,135
18	CULTURAL RESOURCE PRESERVATION (E	$33,813	$14,878	44.0%	$48,691	0.0%	$33,813	$14,878	$48,691	$0	$48,691	37.0%	$46,315	$20,379	$66,694
	#N/A	$0	$0	-	$0	-	$0	$0	$0	$0	$0	-	$0	$0	$0
	#N/A	$0	$0	-	$0	-	$0	$0	$0	$0	$0	-	$0	$0	$0
	#N/A	$0	$0	-	$0	-	$0	$0	$0	$0	$0	-	$0	$0	$0
	#N/A	$0	$0	-	$0	-	$0	$0	$0	$0	$0	-	$0	$0	$0
	#N/A	$0	$0	-	$0	-	$0	$0	$0	$0	$0	-	$0	$0	$0
	#N/A	$0	$0	-	$0	-	$0	$0	$0	$0	$0	-	$0	$0	$0
	#N/A	$0	$0	-	$0	-	$0	$0	$0	$0	$0	-	$0	$0	$0
	#N/A	$0	$0	-	$0	-	$0	$0	$0	$0	$0	-	$0	$0	$0
	#N/A	$0	$0	-	$0	-	$0	$0	$0	$0	$0	-	$0	$0	$0
	#N/A														
	CONSTRUCTION ESTIMATE TOTALS:	$761,746	$335,168		$1,096,915	0.0%	$761,746	$335,168	$1,096,915	$0	$1,096,915	39.4%	$1,062,119	$467,332	$1,529,451
01	LANDS AND DAMAGES	$13,875	$1,388	10.0%	$15,263	0.0%	$13,875	$1,388	$15,263	$0	$15,263	10.2%	$15,287	$1,529	$16,816
30	PLANNING, ENGINEERING & DESIGN	$56,802	$24,993	44.0%	$81,794	0.0%	$56,802	$24,993	$81,794	$0	$81,794	20.7%	$68,585	$30,178	$98,763
31	CONSTRUCTION MANAGEMENT	$26,110	$11,489	44.0%	$37,599	0.0%	$26,110	$11,489	$37,599	$0	$37,599	82.1%	$47,557	$20,925	$68,482
	PROJECT COST TOTALS:	$858,533	$373,037	43.5%	$1,231,570		$858,533	$373,037	**$1,231,570**	$0	**$1,231,570**	39.1%	$1,193,548	$519,964	$1,713,512

CHIEF, COST ENGINEERING, Christopher Tilley (Acting)

ESTIMATED TOTAL PROJECT COST: **$1,713,512**

PROJECT MANAGER, Craig Martin

CHIEF, REAL ESTATE, Gaelen Daly

CHIEF, PLANNING, John Kennelly

CHIEF, ENGINEERING, David Margolis

CHIEF, OPERATIONS, Eric Pedersen

CHIEF, CONSTRUCTION, Sean Dolan

CHIEF, CONTRACTING, Sheila Winston-Vincuilla

CHIEF, PM-PB, Janet Harrington

CHIEF, DPM, Scott Acone

**** TOTAL PROJECT COST SUMMARY ****

PROJECT: **Sagamore Bridge Replacement Alternative - 4 Lane Bridge with Auxiliary On/Off Lanes**
PROJECT NO P2 xxxxxx
LOCATION: Cape Cod Canal, Massachusetts

DISTRICT: NAE District
POC: CHIEF, COST ENGINEERING, Christopher Tilley (Acting)

PREPARED: 10/2/2018
UPDATED: 2/28/2020

This Estimate reflects the scope and schedule in report; CCC Bridges Major Rehabilitation Evaluation Report September 2018

Civil Works Work Breakdown Structure		**ESTIMATED COST**				**PROJECT FIRST COST (Constant Dollar Basis)**						**TOTAL PROJECT COST (FULLY FUNDED)**			
SAGAMORE BRIDGE - REPLACEMENT (4 LANES WITH AUXILIARY ON/OFF LANES)						Program Year (Budget EC): 2020 Effective Price Level Date: 1 OCT 19									
WBS NUMBER *A*	Civil Works Feature & Sub-Feature Description *B*	COST ($K) *C*	CNTG ($K) *D*	CNTG (%) *E*	TOTAL ($K) *F*	ESC (%) *G*	COST ($K) *H*	CNTG ($K) *I*	**TOTAL ($K)** *J*	Spent Thru: **1-Oct-19** ($K)	**TOTAL FIRST COST** ($K) *K*	INFLATED (%) *L*	COST ($K) *M*	CNTG ($K) *N*	FULL ($K) *O*
08	ROADS, RAILROADS & BRIDGES Replacem	$232,630	$102,357	44.0%	$334,988	0.0%	$232,630	$102,357	$334,988	$0	$334,988	24.9%	$290,645	$127,884	$418,529
08	ROADS, RAILROADS & BRIDGES Approach	$34,603	$15,226	44.0%	$49,829	0.0%	$34,603	$15,226	$49,829	$0	$49,829	24.9%	$43,233	$19,023	$62,256
08	ROADS, RAILROADS & BRIDGES Major Rep	$4,224	$1,859	44.0%	$6,083	0.0%	$4,224	$1,859	$6,083	$0	$6,083	139.4%	$10,112	$4,449	$14,562
08	ROADS, RAILROADS & BRIDGES Major Rep	$4,224	$1,859	44.0%	$6,083	0.0%	$4,224	$1,859	$6,083	$0	$6,083	332.4%	$18,264	$8,036	$26,300
02	RELOCATIONS (Utilities)	$20,500	$9,020	44.0%	$29,520	0.0%	$20,500	$9,020	$29,520	$0	$29,520	17.8%	$24,142	$10,623	$34,765
18	CULTURAL RESOURCE PRESERVATION (E	$13,362	$5,879	44.0%	$19,241	0.0%	$13,362	$5,879	$19,241	$0	$19,241	24.9%	$16,694	$7,345	$24,039
	#N/A	$0	$0	-	$0	-	$0	$0	$0	$0	$0	-	$0	$0	$0
	#N/A	$0	$0	-	$0	-	$0	$0	$0	$0	$0	-	$0	$0	$0
	#N/A	$0	$0	-	$0	-	$0	$0	$0	$0	$0	-	$0	$0	$0
	#N/A	$0	$0	-	$0	-	$0	$0	$0	$0	$0	-	$0	$0	$0
	#N/A	$0	$0	-	$0	-	$0	$0	$0	$0	$0	-	$0	$0	$0
	#N/A	$0	$0	-	$0	-	$0	$0	$0	$0	$0	-	$0	$0	$0
	#N/A	$0	$0	-	$0	-	$0	$0	$0	$0	$0	-	$0	$0	$0
	#N/A	$0	$0	-	$0	-	$0	$0	$0	$0	$0	-	$0	$0	$0
	#N/A														
	CONSTRUCTION ESTIMATE TOTALS:	$309,544	$136,199		$445,743	0.0%	$309,544	$136,199	$445,743	$0	$445,743	30.2%	$403,091	$177,360	$580,451
01	LANDS AND DAMAGES	$6,925	$693	10.0%	$7,618	0.0%	$6,925	$693	$7,618	$0	$7,618	10.2%	$7,630	$763	$8,393
30	PLANNING, ENGINEERING & DESIGN	$22,586	$9,938	44.0%	$32,524	0.0%	$22,586	$9,938	$32,524	$0	$32,524	27.5%	$28,808	$12,675	$41,483
31	CONSTRUCTION MANAGEMENT	$11,119	$4,892	44.0%	$16,011	0.0%	$11,119	$4,892	$16,011	$0	$16,011	92.7%	$21,422	$9,426	$30,847
	PROJECT COST TOTALS:	$350,174	$151,722	43.3%	$501,895		$350,174	$151,722	**$501,895**	$0	**$501,895**	31.7%	$460,950	$200,224	$661,174

ESTIMATED TOTAL PROJECT COST: $661,174

______________________ **CHIEF, COST ENGINEERING, Christopher Tilley (Acting)**

______________________ **PROJECT MANAGER, Craig Martin**

______________________ **CHIEF, REAL ESTATE, Gaelen Daly**

______________________ **CHIEF, PLANNING, John Kennelly**

______________________ **CHIEF, ENGINEERING, David Margolis**

______________________ **CHIEF, OPERATIONS, Eric Pedersen**

______________________ **CHIEF, CONSTRUCTION, Sean Dolan**

______________________ **CHIEF, CONTRACTING, Sheila Winston-Vincuilla**

______________________ **CHIEF, PM-PB, Janet Harrington**

______________________ **CHIEF, DPM, Scott Acone**

**** TOTAL PROJECT COST SUMMARY ****

**** CONTRACT COST SUMMARY ****

PROJECT: Sagamore Bridge Replacement Alternative - 4 Lane Bridge with Auxiliary On/Off Lanes
LOCATION: Cape Cod Canal, Massachusetts
This Estimate reflects the scope and schedule in report; CCC Bridges Major Rehabilitation Evaluation Report September 2018

DISTRICT: NAE District
POC: CHIEF, COST ENGINEERING, Christopher Tilley (.

PREPARED: 10/2/2018
UPDATED: 2/28/2020

Civil Works Work Breakdown Structure | **ESTIMATED COST** | **PROJECT FIRST COST (Constant Dollar Basis)** | **TOTAL PROJECT COST (FULLY FUNDED)**

SAGAMORE BRIDGE - REPLACEMENT
(4 LANES WITH AUXILIARY ON/OFF LANES)

Estimate Prepared: **28-Feb-20**
Effective Price Level: 1-Oct-19

Program Year (Budget EC): 2020
Effective Price Level Date: 1 OCT 19

WBS NUMBER *A*	Civil Works Feature & Sub-Feature Description *B*	COST ($K) *C*	CNTG ($K) *D*	RISK BASED CNTG (%) *E*	TOTAL ($K) *F*	ESC (%) *G*	COST ($K) *H*	CNTG ($K) *I*	TOTAL ($K) *J*	Mid-Point Date *P*	INFLATED (%) *L*	COST ($K) *M*	CNTG ($K) *N*	FULL ($K) *O*
	01 Contract 01: Bridge Replacement (25-29)													
08	ROADS, RAILROADS & BRIDGES Replacem	$232,630	$102,357	44.0%	$334,988	0.0%	$232,630	$102,357	$334,988	2027Q3	24.9%	$290,645	$127,884	$418,529
02	RELOCATIONS (Utilities)	$20,500	$9,020	44.0%	$29,520	0.0%	$20,500	$9,020	$29,520	2025Q3	17.8%	$24,142	$10,623	$34,765
18	CULTURAL RESOURCE PRESERVATION (E	$13,362	$5,879	44.0%	$19,241	0.0%	$13,362	$5,879	$19,241	2027Q3	24.9%	$16,694	$7,345	$24,039
	CONSTRUCTION ESTIMATE TOTALS:	$266,492	$117,257	44.0%	**$383,749**		$266,492	$117,257	$383,749			$331,481	$145,852	$477,333
01	LANDS AND DAMAGES	$6,925	$693	10.0%	$7,618	0.0%	$6,925	$693	$7,618	2023Q2	10.2%	$7,630	$763	$8,393
30	PLANNING, ENGINEERING & DESIGN													
7.1%	Project Management	$18,973	$8,348	44.0%	$27,321	0.0%	$18,973	$8,348	$27,321	2023Q2	13.0%	$21,441	$9,434	$30,875
	Planning & Environmental Compliance	INC.		44.0%		0.0%		$0	$0	0	13.0%	$0	$0	$0
	Engineering & Design	INC.		44.0%		0.0%		$0	$0	0	13.0%	$0	$0	$0
	Reviews, ATRs, IEPRs, VE	INC.		44.0%		0.0%		$0	$0	0	13.0%	$0	$0	$0
	Life Cycle Updates (cost, schedule, risks)	INC.		44.0%		0.0%		$0	$0	0	13.0%	$0	$0	$0
	Contracting & Reprographics	INC.		44.0%		0.0%		$0	$0	0	13.0%	$0	$0	$0
	Engineering During Construction	INC.		44.0%		0.0%		$0	$0	0	32.6%	$0	$0	$0
	Planning During Construction	INC.		44.0%		0.0%		$0	$0	0	32.6%	$0	$0	$0
	Project Operations	INC.		44.0%		0.0%		$0	$0	0	13.0%	$0	$0	$0
31	CONSTRUCTION MANAGEMENT													
2.5%	Construction Management	$6,662	$2,931	44.0%	$9,594	0.0%	$6,662	$2,931	$9,594	2027Q3	32.6%	$8,834	$3,887	$12,721
	Project Operation:	INC.		44.0%		0.0%		$0	$0	0	32.6%	$0	$0	$0
	Project Management	INC.		44.0%		0.0%		$0	$0	0	32.6%	$0	$0	$0
	CONTRACT COST TOTALS:	$299,052	$129,229		$428,281		$299,052	$129,229	$428,281			$369,386	$159,936	$529,321

**** TOTAL PROJECT COST SUMMARY ****

**** CONTRACT COST SUMMARY ****

PROJECT: Sagamore Bridge Replacement Alternative - 4 Lane Bridge with Auxiliary On/Off Lanes
LOCATION: Cape Cod Canal, Massachusetts
This Estimate reflects the scope and schedule in report; CCC Bridges Major Rehabilitation Evaluation Report September 2018

DISTRICT: NAE District
POC: CHIEF, COST ENGINEERING, Christopher Tilley (.

PREPARED: 10/2/2018
UPDATED: 2/28/2020

Civil Works Work Breakdown Structure		**ESTIMATED COST**				**PROJECT FIRST COST (Constant Dollar Basis)**				**TOTAL PROJECT COST (FULLY FUNDED)**				
	SAGAMORE BRIDGE - REPLACEMENT (4 LANES WITH AUXILIARY ON/OFF LANES)	Estimate Prepared:			**28-Feb-20**	Program Year (Budget EC):			2020					
		Effective Price Level:			1-Oct-19	Effective Price Level Date:			1 OCT 19					
WBS NUMBER ***A***	Civil Works Feature & Sub-Feature Description ***B***	COST ($K) ***C***	CNTG ($K) ***D***	CNTG (%) ***E***	TOTAL ($K) ***F***	ESC (%) ***G***	COST ($K) ***H***	CNTG ($K) ***I***	TOTAL ($K) ***J***	Mid-Point Date ***P***	INFLATED (%) ***L***	COST ($K) ***M***	CNTG ($K) ***N***	FULL ($K) ***O***
	01 Contract 01: Bridge Approaches (25-29, State Funded)													
	#N/A													
08	ROADS, RAILROADS & BRIDGES Approach	$34,603	$15,226	44.0%	$49,829	0.0%	$34,603	$15,226	$49,829	2027Q3	24.9%	$43,233	$19,023	$62,256
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	CONSTRUCTION ESTIMATE TOTALS:	$34,603	$15,226	44.0%	**$49,829**		$34,603	$15,226	$49,829			$43,233	$19,023	$62,256
01	LANDS AND DAMAGES	$0	$0	0.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
30	PLANNING, ENGINEERING & DESIGN													
8.0%	Project Management	$2,768	$1,218	44.0%	$3,986	0.0%	$2,768	$1,218	$3,986	2023Q2	13.0%	$3,128	$1,376	$4,505
	Planning & Environmental Compliance	INC.		44.0%		0.0%		$0	$0	0	13.0%	$0	$0	$0
	Engineering & Design	INC.		44.0%		0.0%		$0	$0	0	13.0%	$0	$0	$0
	Reviews, ATRs, IEPRs, VE	INC.		44.0%		0.0%		$0	$0	0	13.0%	$0	$0	$0
	Life Cycle Updates (cost, schedule, risks)	INC.		44.0%		0.0%		$0	$0	0	13.0%	$0	$0	$0
	Contracting & Reprographics	INC.		44.0%		0.0%		$0	$0	0	13.0%	$0	$0	$0
	Engineering During Construction	INC.		44.0%		0.0%		$0	$0	0	32.6%	$0	$0	$0
	Planning During Construction	INC.		44.0%		0.0%		$0	$0	0	32.6%	$0	$0	$0
	Project Operations	INC.		44.0%		0.0%		$0	$0	0	13.0%	$0	$0	$0
31	CONSTRUCTION MANAGEMENT													
8.0%	Construction Management	$2,768	$1,218	44.0%	$3,986	0.0%	$2,768	$1,218	$3,986	2027Q3	32.6%	$3,671	$1,615	$5,286
	Project Operation:	INC.		44.0%		0.0%		$0	$0	0	32.6%	$0	$0	$0
	Project Management	INC.		44.0%		0.0%		$0	$0	0	32.6%	$0	$0	$0
	CONTRACT COST TOTALS:	$40,140	$17,662		**$57,802**		$40,140	$17,662	$57,802			$50,032	$22,014	**$72,046**

**** TOTAL PROJECT COST SUMMARY ****

**** CONTRACT COST SUMMARY ****

PROJECT: Sagamore Bridge Replacement Alternative - 4 Lane Bridge with Auxiliary On/Off Lanes
LOCATION: Cape Cod Canal, Massachusetts
This Estimate reflects the scope and schedule in report; CCC Bridges Major Rehabilitation Evaluation Report September 2018

DISTRICT: NAE District
POC: CHIEF, COST ENGINEERING, Christopher Tilley (.

PREPARED: 10/2/2018
UPDATED: 2/28/2020

Civil Works Work Breakdown Structure		**ESTIMATED COST**				**PROJECT FIRST COST (Constant Dollar Basis)**				**TOTAL PROJECT COST (FULLY FUNDED)**				
SAGAMORE BRIDGE - REPLACEMENT (4 LANES WITH AUXILIARY ON/OFF LANES)		Estimate Prepared: Effective Price Level:			**28-Feb-20** 1-Oct-19	Program Year (Budget EC): Effective Price Level Date:			2020 1 OCT 19					
WBS NUMBER *A*	Civil Works Feature & Sub-Feature Description *B*	COST ($K) *C*	CNTG ($K) *D*	CNTG (%) *E*	TOTAL ($K) *F*	ESC (%) *G*	COST ($K) *H*	CNTG ($K) *I*	TOTAL ($K) *J*	Mid-Point Date *P*	INFLATED (%) *L*	COST ($K) *M*	CNTG ($K) *N*	FULL ($K) *O*
	02 Contract 02: Major Repairs (49)													
	#N/A													
	#N/A													
08	ROADS, RAILROADS & BRIDGES Major Rep	$4,224	$1,859	44.0%	$6,083	0.0%	$4,224	$1,859	$6,083	2049Q3	139.4%	$10,112	$4,449	$14,562
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	CONSTRUCTION ESTIMATE TOTALS:	$4,224	$1,859	44.0%	**$6,083**		$4,224	$1,859	$6,083			$10,112	$4,449	$14,562
01	LANDS AND DAMAGES	$0	$0	0.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
30	PLANNING, ENGINEERING & DESIGN													
10.0%	Project Management	$422	$186	44.0%	$608	0.0%	$422	$186	$608	2048Q2	206.2%	$1,293	$569	$1,863
	Planning & Environmental Compliance	INC.		44.0%		0.0%		$0	$0	0	206.2%	$0	$0	$0
	Engineering & Design	INC.		44.0%		0.0%		$0	$0	0	206.2%	$0	$0	$0
	Reviews, ATRs, IEPRs, VE	INC.		44.0%		0.0%		$0	$0	0	206.2%	$0	$0	$0
	Life Cycle Updates (cost, schedule, risks)	INC.		44.0%		0.0%		$0	$0	0	206.2%	$0	$0	$0
	Contracting & Reprographics	INC.		44.0%		0.0%		$0	$0	0	206.2%	$0	$0	$0
	Engineering During Construction	INC.		44.0%		0.0%		$0	$0	0	222.4%	$0	$0	$0
	Planning During Construction	INC.		44.0%		0.0%		$0	$0	0	222.4%	$0	$0	$0
	Project Operations	INC.		44.0%		0.0%		$0	$0	0	206.2%	$0	$0	$0
31	CONSTRUCTION MANAGEMENT													
20.0%	Construction Management	$844	$371	44.0%	$1,215	0.0%	$844	$371	$1,215	2049Q3	222.4%	$2,721	$1,197	$3,919
	Project Operation:	INC.		44.0%		0.0%		$0	$0	0	222.4%	$0	$0	$0
	Project Management	INC.		44.0%		0.0%		$0	$0	0	222.4%	$0	$0	$0
	CONTRACT COST TOTALS:	$5,491	$2,416		**$7,906**		$5,491	$2,416	$7,906			$14,127	$6,216	**$20,343**

**** TOTAL PROJECT COST SUMMARY ****

**** CONTRACT COST SUMMARY ****

PROJECT: Sagamore Bridge Replacement Alternative - 4 Lane Bridge with Auxiliary On/Off Lanes
LOCATION: Cape Cod Canal, Massachusetts
This Estimate reflects the scope and schedule in report; CCC Bridges Major Rehabilitation Evaluation Report September 2018

DISTRICT: NAE District
POC: CHIEF, COST ENGINEERING, Christopher Tilley (

PREPARED: 10/2/2018
UPDATED: 2/28/2020

Civil Works Work Breakdown Structure		ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis)				TOTAL PROJECT COST (FULLY FUNDED)				
SAGAMORE BRIDGE - REPLACEMENT (4 LANES WITH AUXILIARY ON/OFF LANES)		Estimate Prepared:			**28-Feb-20**	Program Year (Budget EC):			2020	FULLY FUNDED PROJECT ESTIMATE				
		Effective Price Level:			1-Oct-19	Effective Price Level Date:			1 OCT 19					
WBS NUMBER *A*	Civil Works Feature & Sub-Feature Description *B*	COST ($K) *C*	CNTG ($K) *D*	CNTG (%) *E*	TOTAL ($K) *F*	ESC (%) *G*	COST ($K) *H*	CNTG ($K) *I*	TOTAL ($K) *J*	Mid-Point Date *P*	INFLATED (%) *L*	COST ($K) *M*	CNTG ($K) *N*	FULL ($K) *O*
	03 Contract 03: Major Repairs (69)													
	#N/A													
	#N/A													
	#N/A													
08	ROADS, RAILROADS & BRIDGES Major Rep	$4,224	$1,859	44.0%	$6,083	0.0%	$4,224	$1,859	$6,083	2069Q3	332.4%	$18,264	$8,036	$26,300
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	CONSTRUCTION ESTIMATE TOTALS:	$4,224	$1,859	44.0%	**$6,083**		$4,224	$1,859	$6,083			$18,264	$8,036	$26,300
01	LANDS AND DAMAGES	$0	$0	0.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
30	PLANNING, ENGINEERING & DESIGN													
10.0%	Project Management	$422	$186	44.0%	$608	0.0%	$422	$186	$608	2068Q2	597.2%	$2,945	$1,296	$4,241
	Planning & Environmental Compliance	INC.		44.0%		0.0%		$0	$0	0	597.2%	$0	$0	$0
	Engineering & Design	INC.		44.0%		0.0%		$0	$0	0	597.2%	$0	$0	$0
	Reviews, ATRs, IEPRs, VE	INC.		44.0%		0.0%		$0	$0	0	597.2%	$0	$0	$0
	Life Cycle Updates (cost, schedule, risks)	INC.		44.0%		0.0%		$0	$0	0	597.2%	$0	$0	$0
	Contracting & Reprographics	INC.		44.0%		0.0%		$0	$0	0	597.2%	$0	$0	$0
	Engineering During Construction	INC.		44.0%		0.0%		$0	$0	0	634.1%	$0	$0	$0
	Planning During Construction	INC.		44.0%		0.0%		$0	$0	0	634.1%	$0	$0	$0
	Project Operations	INC.		44.0%		0.0%		$0	$0	0	597.2%	$0	$0	$0
31	CONSTRUCTION MANAGEMENT													
20.0%	Construction Management	$844	$371	44.0%	$1,215	0.0%	$844	$371	$1,215	2069Q3	634.1%	$6,196	$2,726	$8,922
	Project Operation:	INC.		44.0%		0.0%		$0	$0	0	634.1%	$0	$0	$0
	Project Management	INC.		44.0%		0.0%		$0	$0	0	634.1%	$0	$0	$0
	CONTRACT COST TOTALS:	$5,491	$2,416		**$7,906**		$5,491	$2,416	$7,906			$27,405	$12,058	**$39,464**

**** TOTAL PROJECT COST SUMMARY ****

PROJECT: Bourne Bridge Replacement Alternative - 4 Lane Bridge with Auxiliary On/Off Lanes
PROJECT NO P2 xxxxxx
LOCATION: Cape Cod Canal, Massachusetts

DISTRICT: NAE District
POC: CHIEF, COST ENGINEERING, Christopher Tilley (Acting)

PREPARED: 10/2/2018
UPDATED: 2/28/2020

This Estimate reflects the scope and schedule in report; CCC Bridges Major Rehabilitation Evaluation Report September 2018

BOURNE BRIDGE - REPLACEMENT
(4 LANES WITH AUXILIARY ON/OFF LANES)

Program Year (Budget EC): 2020
Effective Price Level Date: 1 OCT 19

Civil Works Work Breakdown Structure		ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis)						TOTAL PROJECT COST (FULLY FUNDED)			
WBS NUMBER A	Civil Works Feature & Sub-Feature Description B	COST ($K) C	CNTG ($K) D	CNTG (%) E	TOTAL ($K) F	ESC (%) G	COST ($K) H	CNTG ($K) I	TOTAL ($K) J	Spent Thru: 1-Oct-19 ($K)	TOTAL FIRST COST ($K) K	INFLATED (%) L	COST ($K) M	CNTG ($K) N	FULL ($K) O
08	ROADS, RAILROADS & BRIDGES Replacem	$355,478	$156,410	44.0%	$511,888	0.0%	$355,478	$156,410	$511,888	$0	$511,888	44.8%	$514,867	$226,541	$741,408
08	ROADS, RAILROADS & BRIDGES Approach	$53,549	$23,562	44.0%	$77,111	0.0%	$53,549	$23,562	$77,111	$0	$77,111	44.8%	$77,560	$34,126	$111,686
08	ROADS, RAILROADS & BRIDGES Major Rep	$4,224	$1,859	44.0%	$6,083	0.0%	$4,224	$1,859	$6,083	$0	$6,083	177.5%	$11,723	$5,158	$16,881
02	RELOCATIONS (Utilities)	$18,500	$8,140	44.0%	$26,640	0.0%	$18,500	$8,140	$26,640	$0	$26,640	36.5%	$25,257	$11,113	$36,370
18	CULTURAL RESOURCE PRESERVATION (E	$20,451	$8,999	44.0%	$29,450	0.0%	$20,451	$8,999	$29,450	$0	$29,450	44.8%	$29,621	$13,033	$42,655
	#N/A	$0	$0	-	$0	-	$0	$0	$0	$0	$0	-	$0	$0	$0
	#N/A	$0	$0	-	$0	-	$0	$0	$0	$0	$0	-	$0	$0	$0
	#N/A	$0	$0	-	$0	-	$0	$0	$0	$0	$0	-	$0	$0	$0
	#N/A	$0	$0	-	$0	-	$0	$0	$0	$0	$0	-	$0	$0	$0
	#N/A	$0	$0	-	$0	-	$0	$0	$0	$0	$0	-	$0	$0	$0
	#N/A	$0	$0	-	$0	-	$0	$0	$0	$0	$0	-	$0	$0	$0
	#N/A	$0	$0	-	$0	-	$0	$0	$0	$0	$0	-	$0	$0	$0
	#N/A	$0	$0	-	$0	-	$0	$0	$0	$0	$0	-	$0	$0	$0
	#N/A	$0	$0	-	$0	-	$0	$0	$0	$0	$0	-	$0	$0	$0
	#N/A														
	CONSTRUCTION ESTIMATE TOTALS:	$452,202	$198,969		$651,172	0.0%	$452,202	$198,969	$651,172	$0	$651,172	45.7%	$659,028	$289,972	$949,000
01	LANDS AND DAMAGES	$6,950	$695	10.0%	$7,645	0.0%	$6,950	$695	$7,645	$0	$7,645	10.2%	$7,657	$766	$8,423
30	PLANNING, ENGINEERING & DESIGN	$34,216	$15,055	44.0%	$49,270	0.0%	$34,216	$15,055	$49,270	$0	$49,270	16.3%	$39,777	$17,502	$57,280
31	CONSTRUCTION MANAGEMENT	$14,992	$6,596	44.0%	$21,588	0.0%	$14,992	$6,596	$21,588	$0	$21,588	74.3%	$26,135	$11,499	$37,634
	PROJECT COST TOTALS:	$508,360	$221,315	43.5%	$729,675		$508,360	$221,315	**$729,675**	$0	**$729,675**	44.2%	$732,598	$319,740	$1,052,337

ESTIMATED TOTAL PROJECT COST: $1,052,337

_____________________________ **CHIEF, COST ENGINEERING, Christopher Tilley (Acting)**

_____________________________ **PROJECT MANAGER, Craig Martin**

_____________________________ **CHIEF, REAL ESTATE, Gaelen Daly**

_____________________________ **CHIEF, PLANNING, John Kennelly**

_____________________________ **CHIEF, ENGINEERING, David Margolis**

_____________________________ **CHIEF, OPERATIONS, Eric Pedersen**

_____________________________ **CHIEF, CONSTRUCTION, Sean Dolan**

_____________________________ **CHIEF, CONTRACTING, Sheila Winston-Vincuilla**

_____________________________ **CHIEF, PM-PB, Janet Harrington**

_____________________________ **CHIEF, DPM, Scott Acone**

**** TOTAL PROJECT COST SUMMARY ****

**** CONTRACT COST SUMMARY ****

PROJECT: Bourne Bridge Replacement Alternative - 4 Lane Bridge with Auxiliary On/Off Lanes
LOCATION: Cape Cod Canal, Massachusetts
This Estimate reflects the scope and schedule in report; CCC Bridges Major Rehabilitation Evaluation Report September 2018

DISTRICT: NAE District
POC: CHIEF, COST ENGINEERING, Christopher Tilley (.

PREPARED: 10/2/2018
UPDATED: 2/28/2020

Civil Works Work Breakdown Structure		ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis)				TOTAL PROJECT COST (FULLY FUNDED)				
BOURNE BRIDGE - REPLACEMENT (4 LANES WITH AUXILIARY ON/OFF LANES)		Estimate Prepared: Effective Price Level:			**28-Feb-20** 1-Oct-19	Program Year (Budget EC): Effective Price Level Date:			2020 1 OCT 19					
				RISK BASED										
WBS NUMBER *A*	Civil Works Feature & Sub-Feature Description *B*	COST ($K) *C*	CNTG ($K) *D*	CNTG (%) *E*	TOTAL ($K) *F*	ESC (%) *G*	COST ($K) *H*	CNTG ($K) *I*	TOTAL ($K) *J*	Mid-Point Date *P*	INFLATED (%) *L*	COST ($K) *M*	CNTG ($K) *N*	FULL ($K) *O*
	01 Contract 01: Bridge Replacement (30-34)													
08	ROADS, RAILROADS & BRIDGES Replacem	$355,478	$156,410	44.0%	$511,888	0.0%	$355,478	$156,410	$511,888	2032Q3	44.8%	$514,867	$226,541	$741,408
02	RELOCATIONS (Utilities)	$18,500	$8,140	44.0%	$26,640	0.0%	$18,500	$8,140	$26,640	2030Q3	36.5%	$25,257	$11,113	$36,370
18	CULTURAL RESOURCE PRESERVATION (E	$20,451	$8,999	44.0%	$29,450	0.0%	$20,451	$8,999	$29,450	2032Q3	44.8%	$29,621	$13,033	$42,655
	CONSTRUCTION ESTIMATE TOTALS:	$394,429	$173,549	44.0%	**$567,978**		$394,429	$173,549	$567,978			$569,745	$250,688	$820,433
01	LANDS AND DAMAGES	$6,950	$695	10.0%	$7,645	0.0%	$6,950	$695	$7,645	2023Q2	10.2%	$7,657	$766	$8,423
30	PLANNING, ENGINEERING & DESIGN													
7.2%	Project Management	$28,438	$12,513	44.0%	$40,951	0.0%	$28,438	$12,513	$40,951	2023Q2	13.0%	$32,137	$14,140	$46,277
	Planning & Environmental Compliance	INC.		44.0%		0.0%		$0	$0	0	13.0%	$0	$0	$0
	Engineering & Design	INC.		44.0%		0.0%		$0	$0	0	13.0%	$0	$0	$0
	Reviews, ATRs, IEPRs, VE	INC.		44.0%		0.0%		$0	$0	0	13.0%	$0	$0	$0
	Life Cycle Updates (cost, schedule, risks)	INC.		44.0%		0.0%		$0	$0	0	13.0%	$0	$0	$0
	Contracting & Reprographics	INC.		44.0%		0.0%		$0	$0	0	13.0%	$0	$0	$0
	Engineering During Construction	INC.		44.0%		0.0%		$0	$0	0	61.1%	$0	$0	$0
	Planning During Construction	INC.		44.0%		0.0%		$0	$0	0	61.1%	$0	$0	$0
	Project Operations	INC.		44.0%		0.0%		$0	$0	0	13.0%	$0	$0	$0
31	CONSTRUCTION MANAGEMENT													
2.5%	Construction Management	$9,861	$4,339	44.0%	$14,199	0.0%	$9,861	$4,339	$14,199	2032Q3	61.1%	$15,881	$6,988	$22,868
	Project Operation:	INC.		44.0%		0.0%		$0	$0	0	61.1%	$0	$0	$0
	Project Management	INC.		44.0%		0.0%		$0	$0	0	61.1%	$0	$0	$0
	CONTRACT COST TOTALS:	$439,678	$191,095		$630,773		$439,678	$191,095	$630,773			$625,421	$272,582	$898,002

**** TOTAL PROJECT COST SUMMARY ****

**** CONTRACT COST SUMMARY ****

PROJECT: Bourne Bridge Replacement Alternative - 4 Lane Bridge with Auxiliary On/Off Lanes
LOCATION: Cape Cod Canal, Massachusetts
This Estimate reflects the scope and schedule in report; CCC Bridges Major Rehabilitation Evaluation Report September 2018

DISTRICT: NAE District
POC: CHIEF, COST ENGINEERING, Christopher Tilley (
PREPARED: 10/2/2018
UPDATED: 2/28/2020

Civil Works Work Breakdown Structure		**ESTIMATED COST**				**PROJECT FIRST COST (Constant Dollar Basis)**				**TOTAL PROJECT COST (FULLY FUNDED)**				
BOURNE BRIDGE - REPLACEMENT (4 LANES WITH AUXILIARY ON/OFF LANES)		Estimate Prepared: Effective Price Level:			**28-Feb-20** 1-Oct-19	Program Year (Budget EC): Effective Price Level Date:			2020 1 OCT 19					
WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Mid-Point Date	INFLATED (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*	*P*	*L*	*M*	*N*	*O*
	01 Contract 01: Bridge Approaches (30-34, State Funded)													
	#N/A													
08	ROADS, RAILROADS & BRIDGES Approach	$53,549	$23,562	44.0%	$77,111	0.0%	$53,549	$23,562	$77,111	2032Q3	44.8%	$77,560	$34,126	$111,686
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	CONSTRUCTION ESTIMATE TOTALS:	$53,549	$23,562	44.0%	**$77,111**		$53,549	$23,562	$77,111			$77,560	$34,126	$111,686
01	LANDS AND DAMAGES	$0	$0	0.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
30	PLANNING, ENGINEERING & DESIGN													
10.0%	Project Management	$5,355	$2,356	44.0%	$7,711	0.0%	$5,355	$2,356	$7,711	2023Q2	13.0%	$6,051	$2,663	$8,714
	Planning & Environmental Compliance	INC.		44.0%		0.0%		$0	$0	0	13.0%	$0	$0	$0
	Engineering & Design	INC.		44.0%		0.0%		$0	$0	0	13.0%	$0	$0	$0
	Reviews, ATRs, IEPRs, VE	INC.		44.0%		0.0%		$0	$0	0	13.0%	$0	$0	$0
	Life Cycle Updates (cost, schedule, risks)	INC.		44.0%		0.0%		$0	$0	0	13.0%	$0	$0	$0
	Contracting & Reprographics	INC.		44.0%		0.0%		$0	$0	0	13.0%	$0	$0	$0
	Engineering During Construction	INC.		44.0%		0.0%		$0	$0	0	61.1%	$0	$0	$0
	Planning During Construction	INC.		44.0%		0.0%		$0	$0	0	61.1%	$0	$0	$0
	Project Operations	INC.		44.0%		0.0%		$0	$0	0	13.0%	$0	$0	$0
31	CONSTRUCTION MANAGEMENT													
8.0%	Construction Management	$4,284	$1,885	44.0%	$6,169	0.0%	$4,284	$1,885	$6,169	2032Q3	61.1%	$6,899	$3,036	$9,935
	Project Operation:	INC.		44.0%		0.0%		$0	$0	0	61.1%	$0	$0	$0
	Project Management	INC.		44.0%		0.0%		$0	$0	0	61.1%	$0	$0	$0
	CONTRACT COST TOTALS:	$63,188	$27,803		**$90,991**		$63,188	$27,803	$90,991			$90,510	$39,825	**$130,335**

**** TOTAL PROJECT COST SUMMARY ****

**** CONTRACT COST SUMMARY ****

PROJECT: Bourne Bridge Replacement Alternative - 4 Lane Bridge with Auxiliary On/Off Lanes
LOCATION: Cape Cod Canal, Massachusetts
This Estimate reflects the scope and schedule in report; CCC Bridges Major Rehabilitation Evaluation Report September 2018

DISTRICT: NAE District
POC: CHIEF, COST ENGINEERING, Christopher Tilley (.

PREPARED: 10/2/2018
UPDATED: 2/28/2020

Civil Works Work Breakdown Structure		ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis)				TOTAL PROJECT COST (FULLY FUNDED)				
BOURNE BRIDGE - REPLACEMENT (4 LANES WITH AUXILIARY ON/OFF LANES)		Estimate Prepared: Effective Price Level:			**28-Feb-20** 1-Oct-19	Program Year (Budget EC): Effective Price Level Date:			2020 1 OCT 19					
WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Mid-Point Date	INFLATED (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	***B***	***C***	***D***	***E***	***F***	***G***	***H***	***I***	***J***	***P***	***L***	***M***	***N***	***O***
	02 Contract 02: Major Repairs (54)													
	#N/A													
	#N/A													
08	ROADS, RAILROADS & BRIDGES Major Rep	$4,224	$1,859	44.0%	$6,083	0.0%	$4,224	$1,859	$6,083	2054Q3	177.5%	$11,723	$5,158	$16,881
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	#N/A													
	CONSTRUCTION ESTIMATE TOTALS:	$4,224	$1,859	44.0%	**$6,083**		$4,224	$1,859	$6,083			$11,723	$5,158	$16,881
01	LANDS AND DAMAGES	$0	$0	0.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
30	PLANNING, ENGINEERING & DESIGN													
10.0%	Project Management	$422	$186	44.0%	$608	0.0%	$422	$186	$608	2053Q2	276.2%	$1,589	$699	$2,288
	Planning & Environmental Compliance	INC.		44.0%		0.0%		$0	$0	0	276.2%	$0	$0	$0
	Engineering & Design	INC.		44.0%		0.0%		$0	$0	0	276.2%	$0	$0	$0
	Reviews, ATRs, IEPRs, VE	INC.		44.0%		0.0%		$0	$0	0	276.2%	$0	$0	$0
	Life Cycle Updates (cost, schedule, risks)	INC.		44.0%		0.0%		$0	$0	0	276.2%	$0	$0	$0
	Contracting & Reprographics	INC.		44.0%		0.0%		$0	$0	0	276.2%	$0	$0	$0
	Engineering During Construction	INC.		44.0%		0.0%		$0	$0	0	296.1%	$0	$0	$0
	Planning During Construction	INC.		44.0%		0.0%		$0	$0	0	296.1%	$0	$0	$0
	Project Operations	INC.		44.0%		0.0%		$0	$0	0	276.2%	$0	$0	$0
31	CONSTRUCTION MANAGEMENT													
20.1%	Construction Management	$847	$373	44.0%	$1,220	0.0%	$847	$373	$1,220	2054Q3	296.1%	$3,355	$1,476	$4,831
	Project Operation:	INC.		44.0%		0.0%		$0	$0	0	296.1%	$0	$0	$0
	Project Management	INC.		44.0%		0.0%		$0	$0	0	296.1%	$0	$0	$0
	CONTRACT COST TOTALS:	$5,494	$2,417		**$7,911**		$5,494	$2,417	$7,911			$16,667	$7,333	**$24,000**

US Army Corps
Of Engineers ®

CAPE COD CANAL HIGHWAY BRIDGES

BOURNE, MASSACHUSETTS

MAJOR REHABILITATION EVALUATION REPORT

APPENDIX D

ECONOMICS

This Page Intentionally Left Blank

TABLE OF CONTENTS

1 CONTENTS

2 Executive Summary 1
  2.1 Methodology 1
  2.2 Cost Comparison 2
  2.3 Conclusion 6
3 INTRODUCTION 7
  3.1 Geographic Scope 8
  3.2 Federal Interest 8
    3.2.1 Purpose 8
    3.2.2 Need 9
  3.3 Cost-Benefit Analysis Framework 9
    3.3.1 Methodology 10
    3.3.1 Alternatives Considered 11
    3.3.2 Discounting 14
    3.3.3 Time Period 14
    3.3.4 Value of Time 15
4 BASE CONDITION (ALTERNATIVE A) 15
  4.1 Existing Condition 15
  4.2 Future Without-Project Condition 17
    4.2.1 Probability of Unsatisfactory Performance 17
    4.2.2 Probabilistic Scenario Analysis 20
    4.2.3 Sagamore Bridge – Bridge Deck Deterioration 21
    4.2.4 Sagamore Bridge – Substructure Deterioration 22
    4.2.1 Sagamore Bridge – Superstructure Deterioration 24
    4.2.2 Bourne Bridge Deck Deterioration 27
    4.2.3 Bourne Bridge – Substructure Deterioration 27
    4.2.4 Bourne Bridge – Superstructure Deterioration 30
  4.3 Traffic Analysis 32
    4.3.1 Traffic Data Collection 32
    4.3.2 Conditions with No Traffic Impediments 34

4.3.3 Value of Time with Traffic Impediments 35
4.3.4 Vehicle Operational Costs 41
4.4 Impacts to Navigation 41
4.4.1 Vessel Trips 42
4.4.2 Commodity Statistics 43
4.4.3 Origin/Destinations 45
4.4.4 Methods 45
4.4.5 Annual Navigation Benefits of the Canal 46
4.4.6 Navigation Impacts of Temporary Canal Closure 48
4.5 Annual Maintenance Costs 48
4.6 Results of Monte Carlo Simulation 49
4.7 Summary of Future Without Project Condition 50
5 ALTERNATIVE B – MAJOR REHABILITATION 50
5.1 Benefits 50
5.1.1 Probability of Unsatisfactory Performance 50
5.1.2 Probabilistic Scenario Analysis 54
5.1.3 Results of Monte Carlo Simulation 54
5.2 Cost 59
5.2.1 Construction Costs 59
5.2.2 Value of Time 60
5.2.3 Total Annualized Cost 62
5.3 Major Rehabilitation – Analysis Results 63
5.3.1 Results – Sagamore Bridge 63
5.4 Summary of Major Rehabilitation Project 67
6 ALTERNATIVE C – REPLACEMENT WITH 4 LANES (2 each direction) 67
6.1 Benefits 67
6.1.1 Probability of Unsatisfactory Performance 67
6.1.2 Probabilistic Scenario Analysis 71
6.1.3 Results of Monte Carlo Simulation 75
6.2 Cost of Alternative 76
6.2.1 Engineering Costs 76
6.2.2 Value of Time 76

6.2.3 Total Annualized Cost 77
6.3 Four Lane Replacement Bridge – Analysis Results 78
6.3.1 Benefit Cost Ratio (BCR) 78
6.4 Summary of New Bridges Project 81
7 ALTERNATIVE D – REPLACEMENT WITH 4 LANES AND 2 AUXILIARY ON/OFF LANES 82
7.1 Benefits 82
7.1.1 Probability of Unsatisfactory Performance 82
7.1.2 Probabilistic Scenario Analysis 82
7.1.3 Results of Monte Carlo Simulation 82
7.2 Cost of Alternative 84
7.2.1 Engineering Costs 84
7.2.2 Value of Time 85
7.2.3 Total Annualized Cost 86
7.3 Bridge Replacement with Acceleration Lanes – Analysis Results 86
7.3.1 Benefit Cost Ratio (BCR) 87
7.4 Summary of New Bridges Project 89
8 Extended Life Value 90
9 2020 Model Updates 90
9.1 Elimination of Alternative C 91
9.2 Update to Discount Rate 91
9.3 Update to Annual O&M Costs 91
9.4 Update to Project Costs 92
9.5 8.5 Alternative A Model Results 93
9.6 Alternative B Model Results 94
9.7 Alternative D Model Results 96
10 SUMMARY OF RESULTS 98
10.1 Tables and Charts 98
10.2 Rank of Alternatives 99
10.3 Conclusion 99
11 APPENDIX 99
11.1 Assumptions 99
11.2 Sensitivity Analysis 101

11.2.1 Sensitivity Analysis on the Hazard Functions 102
11.2.2 Sensitivity Analysis on the Event Tree Probabilities.. 103
11.2.3 Sensitivity Analysis on Project Start Year.. 105
11.2.4 Sensitivity Analysis on the Value of Time 105
11.2.5 Sensitivity Analysis on Concurrent Replacement Bridge Construction............... 106
11.2.6 Sensitivity Analysis on Weight Restrictions... 107

List of Tables

Table D - 1 Costs Associated with Unscheduled Repairs-Results from Monte Carlo Simulations 3
Table D - 2 Costs Associated with Scheduled Construction 4
Table D - 3 Sagamore Bridge Summary Results 5
Table D - 4 Bourne Bridge Summary Results 5
Table D - 5 List of Alternatives 11
Table D - 6: Federal Highway Administration's National Bridge Inventory Condition Ratings. 16
Table D - 7: Component Failure Impacts 21
Table D - 8: Average Travel Time of Major Routes 35
Table D - 9: Average Travel Time by Closure 2014 37
Table D - 10: Average Travel Time by Closure 2040 37
Table D - 11: Percent of Hourly Income and Hourly Value of Time ($/hour) 38
Table D - 12: Value of Time per Hour by Trip Type in 2016 Dollars 39
Table D - 13: GDP Deflator 39
Table D - 14: Value of Time per hour by Trip Type in 2020 Dollars 39
Table D - 15: Cost of Emergency Repairs 40
Table D - 16: Number of Vessels transiting Cape Cod Canal 42
Table D - 17: Cargo Vessel Trips 2012-2017 43
Table D - 18: Cape Cod Freight Traffic, 2012-2017 44
Table D - 19: Cape Cod Canal Freight Traffic, 2012-2017 45
Table D - 20: Steps to Estimate Impact to Navigation 47
Table D - 21: Navigation Impacts 48
Table D - 22: Sagamore Bridge Base Condition Costs 49
Table D - 23: Bourne Bridge Base Condition Costs 49
Table D - 24: Sagamore Bridge Rehabilitation Costs 58
Table D - 25: Bourne Bridge Rehabilitation Costs 58
Table D - 26: Sagamore Bridge Rehabilitation Benefits 58
Table D - 27: Bourne Bridge Rehabilitation Benefits 58
Table D - 28: Sagamore Bridge Rehabilitation Engineering Costs 59
Table D - 29: Bourne Bridge Rehabilitation Engineering Costs 60
Table D - 30: Rehabilitation Lane Closure Durations Estimates 60
Table D - 31: Sagamore Bridge Rehabilitation Construction and Travel Costs 61
Table D - 32: Bourne Bridge Rehabilitation Construction and Travel Costs 61
Table D - 33: Sagamore Bridge Rehabilitation Total Annualized Costs 62
Table D - 34: Bourne Bridge Rehabilitation Total Annualized Costs 63
Table D - 35: Sagamore Bridge Rehabilitation Costs and BCR 64
Table D - 36: Bourne Bridge Rehabilitation Costs and BCR 65
Table D - 37: Sagamore Bridge Replacement 4 Lanes Costs 75
Table D - 38: Bourne Bridge Replacement 4 Lanes Costs 75
Table D - 39: Sagamore Bridge Replacement 4 Lanes Benefits 75
Table D - 40: Bourne Bridge Replacement 4 Lanes Benefits 75

Table D - 41: Sagamore Bridge Replacement 4 Lanes Engineering Costs 76
Table D - 42: Bourne Bridge Replacement 4 Lanes Engineering Costs...................................... 76
Table D - 43: Sagamore Bridge Replacement 4 Lanes Costs 77
Table D - 44: Bourne Bridge Replacement 4 Lanes Costs 77
Table D - 45: Sagamore Bridge Replacement 4 Lanes Total Annualized Cost............................ 77
Table D - 46: Bourne Bridge Replacement 4 Lanes Total Annualized Cost................................ 78
Table D - 47: Sagamore Bridge Replacement 4 Lanes Annual Costs and BCR 79
Table D - 48: Bourne Bridge Replacement 4 Lanes Annual Costs and BCR.............................. 80
Table D - 49: Sagamore Bridge Replacement 4 Lanes with 2 Auxiliary Annual Costs............... 83
Table D - 50: Bourne Bridge Replacement 4 Lanes with 2 Auxiliary Annual Costs 83
Table D - 51: Benefits of Reduced Congestion 83
Table D - 52: Sagamore Bridge Replacement 4 Lanes with 2 Auxiliary Benefits 84
Table D - 53: Bourne Bridge Replacement 4 Lanes with 2 Auxiliary Benefits 84
Table D - 54: Sagamore Bridge Replacement 4 Lanes with 2 Auxiliary Engineering Costs d. ... 84
Table D - 55: Bourne Bridge Replacement 4 Lanes with 2 Auxiliary Engineering Costs 85
Table D - 56: Sagamore Bridge Replacement 4 Lanes with 2 Auxiliary Costs 85
Table D - 57: Bourne Bridge Replacement 4 Lanes with 2 Auxiliary Costs............................... 85
Table D - 58: Sagamore Bridge Replacement 4 Lanes with 2 Auxiliary Total Annualized Cost 86
Table D - 59: Bourne Bridge Replacement 4 Lanes with 2 Auxiliary Total Annualized Cost 86
Table D - 60: Sagamore Bridge Replacement 4 Lanes with 2 Auxiliary Annual Cost and BCR 87
Table D - 61: Bourne Bridge Replacement 4 Lanes with 2 Auxiliary Annual Cost and BCR..... 88
Table D - 62: Sagamore Bridge Updated Rehabilitation Engineering Costs............................... 92
Table D - 63: Bourne Bridge Updated Rehabilitation Engineering Costs................................... 92
Table D - 64: Sagamore Bridge Replacement 4 Lanes with 2 Auxiliary Updated Engineering Costs.. 93
Table D - 65: Bourne Bridge Replacement 4 Lanes with 2 Auxiliary Updated Engineering Costs 93
Table D - 66: Updated Base Condition Life Cycle Costs 93
Table D - 67: Updated Rehabilitation Life Cycle Costs 94
Table D - 68: Updated Rehabilitation Benefits... 94
Table D - 69: Updated Sagamore Bridge Rehabilitation Total Annualized Costs 94
Table D - 70: Updated Bourne Bridge Rehabilitation Total Annualized Costs 95
Table D - 71: Updated Benefits, Costs, and Benefit-Cost Ratio 95
Table D - 72: Updated Replacement Life Cycle Costs... 96
Table D - 73: Updated Replacement Benefits 96
Table D - 74: Updated Sagamore Bridge Rehabilitation Total Annualized Costs 96
Table D - 75: Updated Bourne Bridge Rehabilitation Total Annualized Costs 97
Table D - 76: Updated Benefits, Costs, and Benefit-Cost Ratio 97
Table D - 77: Sagamore Bridge Summary Results... 98
Table D - 78: Bourne Bridge Summary Results 98
Table D - 79: Sensitivity Analysis Hazard Functions Mean BCRs... 102
Table D - 80: Sensitivity Analysis Event Tree Probabilities Mean BCRs 103

Table D - 81: Sensitivity Analysis Project Start Year Mean BCRs... 105
Table D - 82: Sensitivity Analysis Value of Time Mean BCRs.. 106
Table D - 83: Sensitivity Analysis Replacement Bridges Built Concurrently........................... 107
Table D - 84: Sensitivity Analysis Weight Restrictions... 108

List of Figures

Figure D - 1 Location of Corps-operated Facilities and Property Boundaries 7
Figure D - 2 Geographic Scope 9
Figure D - 3: Bridge Components... 17
Figure D - 4: Base Condition Probability of a Bridge Deck Failure 18
Figure D - 5: Base Condition Probability of a Substructure Failure.. 19
Figure D - 6: Base Condition Probability of a Superstructure Failure 19
Figure D - 7: Sagamore Bridge Deck Deterioration Event Tree 23
Figure D - 8: Sagamore Bridge Substructure Deterioration Event Tree....................................... 25
Figure D - 9: Sagamore Superstructure Deterioration Event Tree 26
Figure D - 10: Bourne Bridge Deck Deterioration Event Tree.. 28
Figure D - 11: Bourne Bridge Substructure Deterioration Event Tree... 29
Figure D - 12: Bourne Superstructure Deterioration Event Tree... 31
Figure D - 13: Traffic Routes... 33
Figure D - 14: Average Daily Volume of Traffic 34
Figure D - 15: Sagamore Rehabilitation Probability of a Bridge Deck Failure........................... 51
Figure D - 16: Bourne Rehabilitation Probability of a Bridge Deck Failure............................... 51
Figure D - 17: Sagamore Rehabilitation Probability of a Substructure Failure........................... 52
Figure D - 18: Bourne Rehabilitation Probability of a Substructure Failure............................... 52
Figure D - 19: Sagamore Rehabilitation Probability of a Superstructure Failure........................ 53
Figure D - 20: Bourne Rehabilitation Probability of a Superstructure Failure............................ 53
Figure D - 21: Rehabilitation Bridge Deck Event Tree 55
Figure D - 22: Rehabilitation Substructure Event Tree 56
Figure D - 23: Rehabilitation Superstructure Event Tree 57
Figure D - 24: Sagamore Major Rehabilitation @RISK Output BCR 64
Figure D - 25: Sagamore Major Rehabilitation @RISK Output Net Benefit............................... 65
Figure D - 26: Bourne Major Rehabilitation @RISK Output BCR... 66
Figure D - 27: Bourne Major Rehabilitation @RISK Output Net Benefits................................. 66
Figure D - 28: Sagamore Replacement Probability of a Bridge Deck Failure 68
Figure D - 29: Bourne Replacement Probability of a Bridge Deck Failure................................. 68
Figure D - 30: Sagamore Replacement Probability of a Substructure Failure 69
Figure D - 31: Bourne Replacement Probability of a Substructure Failure................................. 69
Figure D - 32: Sagamore Replacement Probability of a Superstructure Failure 70
Figure D - 33: Bourne Replacement Probability of a Superstructure Failure.............................. 70
Figure D - 34: Replacement Bridge Deck Event Tree.. 72
Figure D - 35: Replacement Substructure Event Tree.. 73

Figure D - 36: Replacement Superstructure Event Tree ... 74
Figure D - 37: Sagamore 4 Lane Replacement @RISK Output BCR ... 79
Figure D - 38: Sagamore 4 Lane Replacement @RISK Output Net Benefits ... 80
Figure D - 39: Bourne 4 Lane Replacement @RISK Output BCR ... 81
Figure D - 40: Bourne 4 Lane Replacement @RISK Output Net Benefits ... 81
Figure D - 41: Sagamore 6 Lane Replacement @RISK Output BCR ... 87
Figure D - 42: Sagamore 6 Lane Replacement @RISK Output BCR Net Benefits ... 88
Figure D - 43: Bourne 6 Lane Replacement @RISK Output BCR ... 89
Figure D - 44: Bourne 6 Lane Replacement @RISK Output Net Benefits ... 89

2 EXECUTIVE SUMMARY

The U.S. Army Corps of Engineers (USACE), New England District, is conducting a multi-year Major Rehabilitation Evaluation Study of the Bourne and Sagamore highway bridges spanning the Cape Cod Canal. The study evaluates the current conditions of the bridges and what alternatives are feasible for the future. The economic analysis is extended over a 50-year period using 2020 as the base year and the Federal Discount Rate currently set at 2. 750 percent for Fiscal Year 2020.

The existing bridges were constructed more than 85 years ago and require frequent maintenance, which is costly and causes significant impacts to traffic crossing the Cape Cod Canal. The highway bridges, and the companion Railroad Bridge constructed during the same era, provide the only means of access to the towns on Cape Cod and Nantucket and Martha's Vineyard. Approximately 215,000 residents and 5 million visitors use these bridges each year.

To better understand the condition of its Civil Works projects the USACE completes a Major Rehabilitation Evaluation Report (MRER) whenever infrastructure maintenance construction costs are expected to exceed $20 million and take more than 2 years of construction to complete. The MRER is based on four pillars of evaluation: a structural engineering risk and reliability analysis of the current structures, cost engineering, economic analysis, and environmental evaluation of all feasible alternatives. An MRER identifies operational and potential reliability issues, as well as opportunities for efficiency improvement, over a 50-year period of analysis.

This study will determine whether standard operation and maintenance, major rehabilitation, or replacement of both bridges will provide the most reliable, fiscally responsible solution for the future. The MRER will provide the basis of decision-making for USACE and Congress on the most cost-effective, safe alternative for critical public transportation across Cape Cod Canal for the next several decades.

As part of the MRER, an economic evaluation was performed to analyze the costs and benefits of the "base" condition and compare it to alternatives. The "base" condition refers to a baseline of continued regular inspections and standard maintenance construction on the bridges. Below is a brief summary of the findings of the economic analysis.

2.1 Methodology

The initial economic analysis focused on four conditions:

1. Alternative A: Base (or without project) condition - continue to maintain the bridges with regularly scheduled maintenance and make emergency funding available for repairs when there is a component failure.
2. Alternative B: major rehabilitation of existing bridges
3. *Alternative C: replacement with two 4-lane bridges (eliminated in final evaluation)*
4. Alternative D: replacement with two 4-lane bridges with auxiliary on/off lanes

The economic analysis evaluates the base condition and then compares that condition to the alternatives. Annual benefits considered for each alternative include the reduction in emergency repair spending, the decrease in traffic delays, and changes in cost to waterway navigation. The annual benefit of each alternative is then compared to its respective cost. An alternative is considered economically justified if it maximizes net annual benefits and its benefit cost ratio (annual benefit divided by annual cost) is greater than one.

The analysis is performed using a risk based approach to compare costs and benefits of each alternative to the base condition. Reliability functions from engineering event trees are utilized to simulate possible component failures and associated repair costs. The three engineering components that could experience failure are the *bridge deck, substructure,* and *superstructure*. This analysis is evaluated over a 50-year period using Monte Carlo Simulation to determine long-term costs of the future base condition without-project and the future with alternatives. The model was approved for single-use by the USACE Planning Center of Expertise for Inland Navigation and Risk Informed Economics Division in July 2018. The memo documenting this approval pursuant to EC 1105-2-412 is attached as an addendum to this appendix.

The overall cost of each alternative includes several elements; the cost of the repair itself, the economic cost to vessels that cannot use the canal (navigation costs), operation & maintenance costs, and the change in value of time incurred by drivers in traffic delays (travel costs) during lane closures for repairs or construction phases.

The value of time is determined using USACE regulation (ER 1105-2-100). Traffic data was modeled by TrafInfo; a transportation consulting company familiar with the Massachusetts Department of Transportation (MassDOT) data. TrafInfo provided Cape Cod traffic study data and forecasts. This traffic data was used to determine the total hours of traffic delay incurred during construction for all travelers crossing the bridges. A monetary value was attributed to these lost productive hours using the average hourly household median income of the surrounding towns as sourced from the US Census Bureau.

2.2 Cost Comparison

A comparison of mean annual costs for the base condition and three alternatives is provided in Table D-1 below. These costs represent the economic impacts of unscheduled component failures and unscheduled maintenance events that will occur over the 50 year period of analysis. Maintaining the bridges in the current, base condition would result in annual repair costs of $123.9 million and $65.2 million for the Sagamore and Bourne Bridge respectively. Under the Major Rehabilitation scenario, those expenses would decrease to $8.7 million for the Sagamore Bridge and $6.1 million for the Bourne Bridge. Replacing the bridges, both with and without the auxiliary lanes, reduces the annual costs further to approximately $4.5 million for the Sagamore Bridge and $7 million for the Bourne Bridge.

Table D - 1 Costs Associated with Unscheduled Repairs-Results from Monte Carlo Simulations

Mean Annual Costs, ($000)					
	Repair Cost	**Navigation Cost**	**Travel Cost**	**O&M Costs**	**Total**
Alt A: Base Condition					
Sagamore	2,800	0.7	120,700	400	**123,900**
Bourne	3,200	0.7	61,700	300	**65,200**
Alt B: Major Rehabilitation					
Sagamore	300	0.6	8,000	400	**8,700**
Bourne	400	0.6	5,400	300	**6,100**
Alt D: Replacement 4 Lanes with on/off Auxiliary					
Sagamore	300	0.1	4,000	200	**4,500**
Bourne	500	0.2	6,300	200	**7,000**

Table D-2 below presents the annual costs for all scheduled construction planned during the major rehabilitation and the replacement alternatives. These costs include the dollar amounts for replacing bridge components in the major rehabilitation, or replacing the entire bridge for the other two alternatives. Costs also include traffic impacts for all scheduled construction periods.

In the major rehabilitation alternative, construction costs of $144.3 million (Sagamore) and $158.9 million (Bourne) are included for additional major repairs that would be required approximately 30 years after the major rehabilitation. Repairs include painting and major steel replacement for floor beams and truss deck. These costs are reduced significantly to $15.8 million and $7.9 million respectively in Alternative D.

Tables D-3 and D-4 provide summary detail of all costs, benefits, and benefit to cost ratios (BCRs) for the major rehabilitation and two bridge replacement alternatives. More detail for the benefit calculations can be found throughout the economic appendix.

Table D - 2 Costs Associated with Scheduled Construction

Sagamore Bridge		
	Cost ($000)	
	Alternative B: Rehabilitation	**Alt D: Replacement 4 Lanes with On/Off Auxiliary**
Construction cost (2020 dollars)	156,300	486,100
Construction cost of additional repair work (2020 dollars)	144,400	15,800
Travel delay costs (2020 dollars)	1,281,000	92,800
Discount factor	2.75%	2.75%
Capital Recovery Factor	0.0370	0.0370
Discounted construction cost	132,900	402,300
Discounted additional repair work	49,700	5,700
Discounted travel delay cost	782,600	33,500
Interest During Construction (IDC)	4,300	27,500
Total Cost	969,500	469,000
Annualized Cost	**35,900**	**17,400**
Bourne Bridge		
Construction cost (2020 dollars)	186,200	721,800
Construction cost of additional repair work (2020 dollars)	158,900	7,900
Travel delay costs (2020 dollars)	948,400	22,200
Discount factor	2.75%	2.75%
Capital Recovery Factor	0.0370	0.0370
Discounted construction cost	142,000	521,600
Discounted additional rehab work	47,200	3,100
Discounted travel delay cost	536,700	8,900
Interest During Construction (IDC)	5,200	40,800
Total Cost	731,100	574,400
Annualized Cost	**27,100**	**21,300**

Table D - 3 Sagamore Bridge Summary Results

Scenario Simulation Comparison					
	Annual Life Cycle Cost* ($000) (from Table 1)	Annualized Costs ($000) (from Table 2)	Annualized Benefits ($000)	Annualized Net Benefits ($000)	BCR
Alt A: Base Condition					
Mean	123,900	-	-	-	-
Median	119,000	-	-	-	-
Alt B: Major Rehabilitation					
Mean	8,800	35,900	115,100	79,200	3.2
Median	6,600	35,900	112,400	76,500	3.1
Alt D: Replacement 4 Lanes with on/off Auxiliary					
Mean	4,400	17,400	119,500	102,100	6.9
Median	2,900	17,400	116,100	98,700	6.7

Table D - 4 Bourne Bridge Summary Results

Scenario Simulation Comparison					
	Annual Life Cycle Cost* ($000) (from Table 1)	Annualized Costs ($000) (from Table 2)	Annualized Benefits ($000)	Annualized Net Benefits ($000)	BCR
Alt A: Base Condition					
Mean	65,200	-	-	-	-
Median	62,700	-	-	-	-
Alt B: Major Rehabilitation					
Mean	6,100	27,100	59,100	32,000	2.2
Median	4,800	27,100	57,900	30,800	2.1
Alt D: Replacement 4 Lanes with on/off Auxiliary					
Mean	6,900	21,300	58,300	37,000	2.7
Median	4,200	21,300	58,500	37,200	2.7

* Life Cycle Cost includes costs to repair structure components as well as the travel delay costs associated with the repair activity.

2.3 Conclusion

Rank of Alternatives:

Based on Net Benefits, the rank of alternatives (with 1 being the most desirable) is:

1. Alternative D: Replacement with two 4-lane bridges with auxiliary on/off lanes
2. Alternative B: Major rehabilitation of existing bridges
3. Alternative A: Base Condition - continue to maintain the bridges with regularly scheduled maintenance and make emergency funding available when there is a component failure to repair the failure.

The economic analysis suggests that fixing the current bridges as components deteriorate will lead to significant costs, particularly costs for travelers delayed in traffic.

The first alternative evaluated was major rehabilitation of the existing bridges. This scenario demonstrated positive net benefits and a benefit-cost-ratio of 3.2 for the Sagamore Bridge and 2.2 for the Bourne Bridge. One advantage of the rehabilitation is a lower initial construction cost for the project when compared to replacing the bridges. The disadvantages are the impact it will have on traffic patterns during the time of construction due to lane and full bridge closures as well as the bridges not being brought up to current engineering standards and regulations.

Alternatives for replacement bridges were also evaluated for two 4-lane bridges (Alternative C) and for two 4-lane bridges with auxiliary on/off lanes (Alternative D). Alternative C was eliminated as this design will not meet current highway safety requirements. Alternative D had higher net benefits and BCRs than the rehabilitation scenario. One disadvantage of the new bridges is the high initial cost of construction. On the other hand, advantages of the replacement bridges are minimal disturbances to traffic during construction and replacing the aging infrastructure with bridges at current engineering standards and regulations.

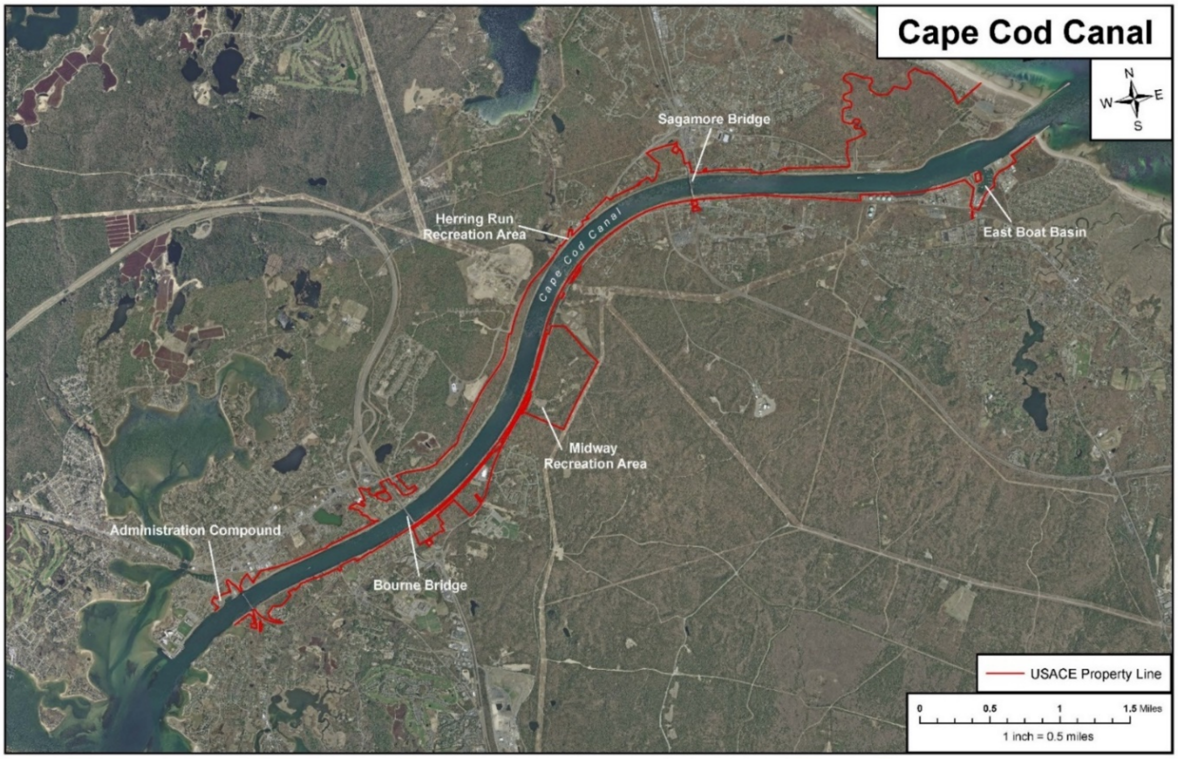
The analysis suggests that the two 4-lane bridges with auxiliary lanes are more economically justifiable given the lower annual costs over 50 years of analysis.

3 INTRODUCTION

Since 1928, the New England District of the Army Corps of Engineers has been responsible for the operation and maintenance of the Cape Cod Canal. The canal is located in Barnstable County with the majority of the Canal in the town of Bourne and the northern boundary located in Sandwich which includes the Scusset Beach State Reservation. With annual visitation exceeding three million, the Cape Cod Canal is one of the Corps' busiest projects and serves as the gateway to historic Cape Cod. The primary mission of the Corps at the Cape Cod Canal is to provide safe navigation to the 14,000 commercial and recreational vessels that transit the 17.5 mile waterway each year. The Corps also owns and operates over 1,000 acres of land surrounding the Canal that provides diverse recreational opportunities such as hiking, biking, and fishing. Figure D-1 shows the location of the Cape Cod Canal and the Corps property boundary.

The canal is spanned by the Cape Cod Canal Railroad Bridge, the Bourne Bridge, and the Sagamore Bridge. The Sagamore Bridge is located in the town of Bourne and carries traffic along Route 6. The bridge is 1,408 feet long and has 4 traffic lanes, 2 in each direction. The Bourne Bridge is also located in Bourne, along Route 28. The Bourne Bridge is larger than the Sagamore Bridge, spanning 2,384 feet and similarly includes 4 lanes of traffic, 2 in each direction. The bridges were constructed between 1933 and 1935. They are owned and operated by the Army Corps of Engineers.

Figure D - 1 Location of Corps-operated Facilities and Property Boundaries



The Bourne and Sagamore bridges are the primary means of transportation on and off Cape Cod and provide access to the ferry terminals on the Cape for the islands of Nantucket and Martha's Vineyard. The bridges provide a daily route for commuters in the surrounding area and the livelihoods of many residents in the area are dependent on access to these bridges. Tourism also plays a vital role in the region's economy. Tourism on the Cape and Islands generated over 100 million state and local tax dollars in 2018. In addition, more than 10,000 jobs were supported by the tourism industry, generating over 350 million dollars in wages in 2018[i]. Therefore, disruption to bridge traffic would be detrimental to the economic prosperity in the region.

The Corps' mission is to provide safe transport to the 215,000 full time Cape Cod residents and millions of annual visitors. With both bridges now over 80 years old and despite ongoing maintenance, they have deteriorated over time and require increasingly more frequent repairs. Therefore this economic appendix will evaluate options for ensuring safe access across the canal.

This economic appendix evaluates the base case condition and compares the base condition to the various alternatives under consideration. The term base condition is synonymous to the without-project condition term used in other USACE documentation. The evaluation is done by comparing the annual benefit of each alternative to its respective cost. An alternative is considered economically justified if it maximizes net annual benefits and its benefit cost ratio (annual benefit divided by annual cost) is greater than one. The cost of each alternative includes the value of time incurred by traffic delays (travel costs) during lane closures for repairs or construction phases. This analysis follows guidance from EP 1130-2-500, Appendix B "Rehabilitation Evaluation Report." Costs and benefits are evaluated at the 2020 price level using the 2019 Federal interest rate for water resources projects of 2.875% and then updated in Section *8.2 Update to Discount Rate* using the 2020 interest rate of 2.750%.

3.1 Geographic Scope

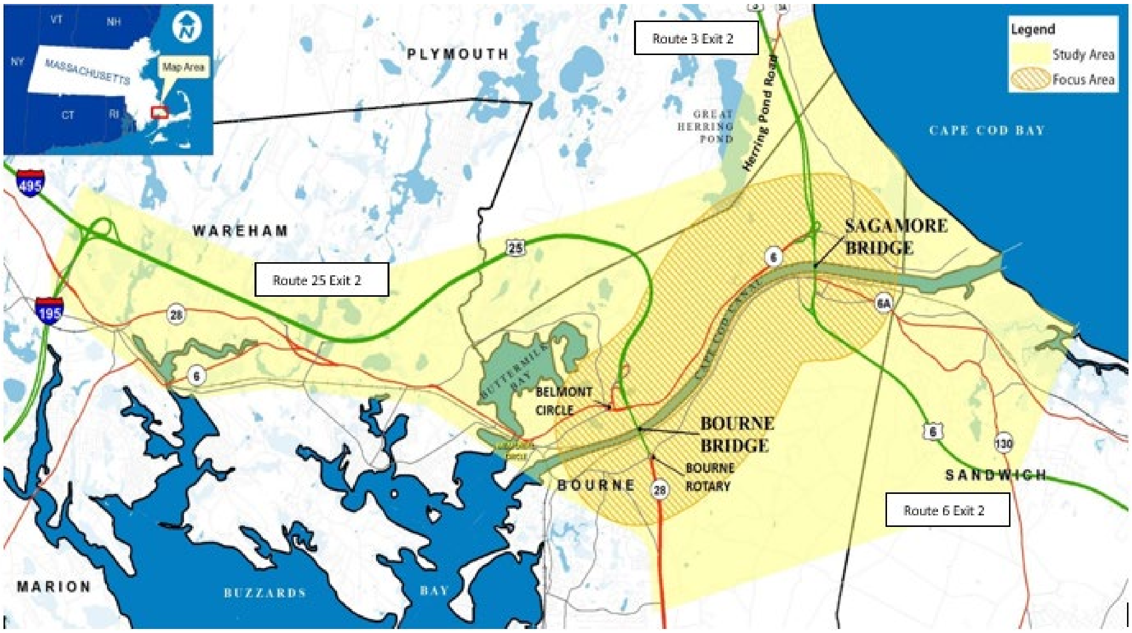
The study area consists of the region between Route 3 Exit 2 (Herring Pond Road) in Plymouth and Route 6 Exit 2 (Route 130, Forestdale Road) in Sandwich, as well as the area between Route 25 Exit 2 (Glen Charlie Road) in Wareham and Route 151 in Mashpee, as illustrated in Figure D – 2.

3.2 Federal Interest

3.2.1 Purpose

The purpose of the Cape Cod Canal Bridges Major Rehabilitation Study is to analyze opportunities for improving the existing deteriorated bridges to provide structures which will maintain reliability of service, improve safety and ease of maintenance, and provide safe, secure, and cost effective access across the Cape Cod Canal. The purpose of this analysis is to evaluate and compare the costs and benefits of the various alternative measures and recommend the most economically justifiable solution.

Figure D - 2 Geographic Scope



3.2.2 Need

The Bourne and Sagamore Bridges provide the only vehicular access to 15 towns and nearly 215,000 full time residents and millions of annual visitors to Cape Cod. The bridges also provide access to 8 offshore island municipalities through the ferry terminals located on Cape Cod. The Bourne and Sagamore Bridges were constructed in 1933. Both bridges are now over 80 years old and despite ongoing maintenance, they have deteriorated over time and require increasingly more frequent repairs. Routine and emergency maintenance activities requiring lane closures cause significant restrictions of each bridge’s carrying capacity during these maintenance/repair events. While some maintenance can be performed outside of normal commuting hours, other emergency repairs cannot. Without major rehabilitation or replacement, travelers will experience more frequent delays and lane closures and the bridges may reach a point where load restrictions may need to be imposed; adversely impacting traffic over both bridges. Routine bridge maintenance will not extend the useful life or improve the reliability of the bridges.

3.3 Cost-Benefit Analysis Framework

The basic criteria for an economically viable project are that the present value of the benefits exceeds the present value of the costs, and/or that the rate of return on the investment exceeds the cost of capital. The benefits represent the incremental economic payoff of the project. The costs are opportunity costs—that is, the value of the foregone alternative investment. The Federal Discount Rate, based on the rate of return on risk-free Treasury securities and currently set at 2.875 percent for Fiscal Year 2019, is used to discount the scenarios. It is updated in Section *8.2 Update to Discount Rate* using the 2020 interest rate of 2.750%.

For this project, the federal government's contribution to operate, repair, rehabilitate or build a bridge represents the cost. The benefits refer to the quantifiable, incremental gains that accrue to the society as a result of the project ("with-project" condition), as compared to the base condition of maintaining the bridges as needed ("without-project" condition). Under the base condition where no improvements are made, it is anticipated that service disruptions will continue and the bridges will eventually close. This is the "baseline" scenario that will be compared to the proposed alternatives of rehabilitation and construction of new bridges. The net benefits are calculated by taking the difference between the base condition and with-project conditions. A benefit-cost ratio greater than one indicates that the project's net benefits outweigh the costs.

3.3.1 Methodology

Economic analysis is performed using a risk based approach. The model was approved for single-use by the USACE Planning Center of Expertise for Inland Navigation and Risk Informed Economics Division in July 2018. The memo documenting this approval pursuant to EC 1105-2-412 is attached as an addendum to this appendix.

Reliability functions from engineering event trees are utilized to simulate life cycle of components and associated repair costs. This analysis is extended over a 50-year period to determine long-term costs of the future base condition without project and the future with alternatives. The costs are estimated in Excel using an add-in, @RISK, to generate Monte Carlo simulations. The outputs of the simulation are the additional costs for the base case and each alternative, the benefit and net benefit of each alternative, and a benefit-cost ratio for each alternative. The net benefit of each alternative is the difference between annual benefit and annual cost. The benefit-cost ratio for an alternative is the annual benefit divided by the annual cost of each alternative. The mean and standard deviation of each output variable is also calculated.

Inputs into the economic analysis are the component failure rates developed in Appendix A – Engineering Reliability Analysis. The three engineering components that could experience failure are the *bridge deck, substructure, and superstructure*. Component failures are the same for both the Bourne Bridge and the Sagamore Bridge. Hazard rates were developed for each component, which indicate the probability of component failure at a point in time.

Monte Carlo Simulation generates a random number between 0 and 1 for each of the 50 years of project life. The random decimal correlates to the probability of failure signaling either a repair is required or no repair is required. Associated with each component failure is a repair cost as well as the value cost of time spent in traffic delays. In some scenarios additional navigation costs would be incurred if the canal were to be closed for vessel traffic. The additional costs due to component failures are discounted in the year of failure. For each iteration of the model these costs are summed over the project life. The model is iterated 100,000 times each year over the fifty years and the average annual costs are obtained by summing the costs over the fifty years and annualizing using the capital recovery factor of 0.0379 based on the 2019 discount rate and updated in Section 8.2 to 0.0370 based on the 2020 discount rate.

In the event of a component failure, subsequent years will continue to show deteriorating conditions and therefore hazard rates are not reset after repairs. Through engineering expert elicitation, it was determined that failures in one component of the bridge deck, substructure, or superstructure do not prevent failure in another area of that component. Hazard functions are instead adjusted after construction is complete in the major rehabilitation and replacement alternatives indicating increased structural soundness.

Benefits are reductions in repair and maintenance costs and travel delay costs between the proposed alternatives and the base condition. Each alternative is evaluated against the base case. Each alternative and the base case have separate sets of hazard indices for each system component. The hazard rates increase over time reflecting the increased probability of failure due to deteriorating conditions.

3.3.1 Alternatives Considered

A number of alternatives were initially considered and are listed in the table provided below.

Table D - 5 List of Alternatives

	Description	**Special Considerations**
Base A	Continued Maintenance and Repairs (Fix as Fails) to Both Existing Bridges as Needed to Maintain Safety. All alternatives are measured against this plan.	This is the Federal Base Plan – the Without Project Condition
B	A Program of Repairs and Major Rehabilitation for Both Bridges to Maintain Safety and Avoid Future Restrictions on Bridge Weight Postings	Major Rehabilitation of Each Bridge is Required about every 45 Years.
C	Replacement of One or Both Highway Bridges with New Bridges Limited to Four Lanes Each	Each Old Bridge would Remain in Service until the New Bridge was Completed
D	Replacement of One or Both Highway Bridges with New Bridges with Four Through-Traffic Lanes and Two Auxiliary Lanes	Each Old Bridge would Remain in Service until the New Bridge was Completed
E	Replacement of One or Both Highway Bridges with New Bridges with Additional (More than Four) Non-Federally Funded Through Traffic Lanes, plus Two Auxiliary Lanes	Each Old Bridge would Remain in Service until the New Bridge was Completed
F	Replacement of Both Highway Bridges with a Single New Bridge	Both Old Bridges would Remain in Service until the New Bridge was Completed
G	Non-USACE Construction of a New Third Highway Bridge	This would be a State implemented Alternative.
H	Replacement of One or Both Highway Bridges with Tunnels	Each Old Bridge would Remain in Service until the New Tunnel was Completed
I	Replacement of Both Bridges with a Single Tunnel	Both Old Bridges would Remain in Service until the New Tunnel was Completed

J	Replacement of One or Both High Level Bridges with Low Level Draw Spans	Each Old Bridge would Remain in Service until the New Bridge was Completed
K	Replacement of Both Bridges with Low Level Crossings on Causeways with Draw Spans for Shallow Draft Navigation	Both Old Bridges would Remain in Service until the New Causeway was Completed
L	Deauthorization and Closure of the Cape Cod Canal, Filling the Land Cut, and Restoration of Surface Highways, Drainage and Estuarine Ecosystems	Includes Retention of the Shallow Draft Harbors at Each End of the Canal (East Boat Basin, Buttermilk Bay and Onset Bay Projects

These initial alternatives were evaluated and screened to reduce the list to only those plans which in terms of likely cost, impacts on the marine and land transportation systems, traffic and environmental impacts, and overall practicability would be implementable.

For a more detailed description of the screening out process please refer to the Major Rehabilitation Evaluation Report and Environmental Assessment section 5.1 Alternatives Considered but Not Carried Forward.

Alternative E was not carried forward because additional through-traffic lanes would not be in accordance with the existing authority for the Federal government for the Cape Cod Canal navigation project. New Federal legislation would be required for any expansion of capacity to be implemented. Additional through traffic lanes would not generate appreciable benefits to traffic without extensive state improvements to region's highway capacity on both side of the Canal, which would carry high costs and greater impact to the environment and the communities. This plan was therefore eliminated from further consideration.

Alternative F was eliminated because a single bridge crossing would require substantial and significant infrastructure construction and involve extensive redesign and major realignment of local surface roads and regional highway connections on both the Cape and mainland sides of the Canal. Additional costs include expensive approach work for navigation clearance and real estate takings including lands from the Massachusetts Military Reservation as well as historical and environmental lands.

The construction of a third bridge, Alternative G was not carried forward. MassDOT initially studied this concept and determined there were significant resource impact issues. Additionally, this alternative does not provide a solution for the existing Bourne and Sagamore Bridges.

Alternatives H and I were eliminated from detailed analysis based on the high cost and extensive impacts on the environment and land uses. Initial cost estimates determined a tunnel would cost at least twice the cost of new bridges.

Alternatives (J, K and L) which involved closure of the Canal by filling, or construction of causeways or low-level fixed bridges or draw spans were eliminated from further consideration. Some of these plans would also constrain or eliminate the Canal as a shallow draft waterway.

These alternatives would degrade the efficiency and safety of coastwise navigation. Restricting or closing the Canal to navigation would be inconsistent with the Congressional authorization for the Canal as a deep-draft waterway and would require legislation to implement.

Alternatives Carried Forward for Economic Evaluation:

Alternative A – Fix as Fails

Alternative B – Rehabilitation of Bridges

Alternative C – Replacement of Bridges with 4 lanes

Alternative D – Replacement of Bridges with 4 lanes plus auxiliary on/off lanes

Elimination of Alternative C

The two existing bridges with their four through traffic lanes were designed and built in the 1930s to serve far lower traffic volumes than those served by the bridges today. Modern highway design guidance, including AASHTO highway and bridge design specifications and MassDOT design guidance require that entrance and exit ramps include auxiliary lanes for entering and exiting traffic to transition into or out of through traffic safely. Today's higher traffic volumes and vehicle speeds require greater distances for traffic to transition. Distance between the on and off ramps, grades, and ramp turn diameters are all typical factors.

The FHWA stated the following in their comment letter:

> *Based on the close proximity of the interchanges and intersections at the end of each bridge, current standards for this type of facility include acceleration and deceleration lanes (also known as auxiliary lanes) going onto the bridges in most, if not all, four ends of the bridges. In final design, analysis will need to be done to determine if the auxiliary lanes should be continuous across each bridge for operational weaving and structural efficiency needs pending on the structure type, long span bridges such as these may gain cost efficiency with a uniform width.*

MassDOT states the following with respect to the need for auxiliary lanes:

> *The design requirements used for the roadways, intersections, and interchanges shall be in accordance with and the 2006 MassDOT Project Development and Design Guide as well as 2018 American Association of State Highway and Transportation Officials (AASHTO) Policy on Geometric Design of Highway and Streets ("the Green Book"). See Chapter 10 of The Green Book which includes Tables 10-4 Minimum Acceleration Lane Lengths for Entrance Terminals…, Table 10-5 Speed Change Lane adjustment factors as a function of grade…, and Table 10-6 Minimum deceleration lane lengths for exit terminals…; these dictate the required lengths for this type of facility include acceleration and deceleration lanes (also known as auxiliary lanes).*

Providing a replacement for the existing spans in-kind with respect to the number of through traffic lanes would not conform to current design guidance for bridges and highways. For this reason, providing new bridges without auxiliary lanes would not be consistent with best practices for traffic safety, and Plan C will not be carried forward into detailed analysis.

Final Array of Alternatives

Alternative A – Fix as Fails

Alternative B – Rehabilitation of Bridges

Alternative D – Replacement of Bridges with 4 lanes plus auxiliary on/off lanes

3.3.2 Discounting

For most transportation investments, costs are incurred in the initial years, while the benefits from the investment accrue over many years into the future. When assessing the costs and benefits of a project, it is necessary to take into account the time value of money by converting the costs and benefits that take place in different years into a common year. This process is known as discounting. Discounting converts future costs and benefits that occur in different years into a value for a common year (present value).

The year 2020 was selected as the base year because the decision on the recommended plan contained within the MRER is expected to be made in 2020. Base year dollars are valued in dollars that are directly comparable to the current dollars for a given year. The base year can be adjusted by multiplying costs and benefits by the respective rate. Ultimately, how the alternatives compare will not change and therefore, adjusting the base year does not impact the final decision made within the report.

The interest rate for discounting, that is, converting benefits and costs to a common time basis, is set each fiscal year in accordance with Section 80 of Public Law 93-251. HQUSACE obtains the rate from U.S. Department of the Treasury, which computes it as the average market yields on interest-bearing marketable securities of the United States that have 15 or more years remaining to maturity.

3.3.3 Time Period

According to ER 1105-2-100, “Planning Guidance Notebook”, US Army Corps reports require a period of analysis. A 50-year analysis is a common timeframe used when analyzing USACE Civil Works construction projects. The analysis will cover a 50-year period from 2020 – 2069. The year 2020 was selected as the start of the economic analysis period because this marks the point at which a decision on the recommended plan contained within the MRER must be made in order to initiate the next phase (PED) of the project and avoid significant expenditures on major rehabilitation of the current Sagamore and Bourne bridges (2025-2030). Once the recommended plan is adopted the next phase of the planning and design process can begin.

3.3.4 Value of Time

The cost of each alternative includes the value of time incurred by traffic delays (travel costs) during lane closures for repairs or construction phases. The value of time is determined using USACE regulation (ER 1105-2-100).

Traffic data was modeled by TrafInfo; a transportation consulting company familiar with the Massachusetts Department of Transportation (MassDOT) data. TrafInfo provided Cape Cod traffic study data and forecasts. This traffic data was used to determine the total hours of traffic delay incurred during construction for all travelers crossing the bridges. A monetary value was attributed to these lost productive hours using the average hourly household median income of the surrounding towns. A more detailed description of this process can be found in section 3.3.3 Value of Time with Traffic Impediments.

4 BASE CONDITION (ALTERNATIVE A)

The base condition refers to the scenario in which the Sagamore and Bourne bridges are operated in the most efficient manner in their current states without the proposed rehabilitation project. The bridges will be repaired as structural failures occur.

4.1 Existing Condition

The overall condition of both the Bourne and Sagamore bridges is becoming worse as the bridges age and major maintenance projects become more frequent. As the condition deteriorates, this leads to the bridges becoming structurally deficient. Both bridges are functionally obsolete and are routinely unable to provide an efficient flow of traffic in conjunction with the current State and local roadway network leading to the bridge approaches.

Bridges are considered “structurally deficient” if significant load-carrying elements are found to be in poor or worse condition due to deterioration and/or damage. A “deficient” bridge typically requires maintenance and repair and eventual rehabilitation or replacement to address deficiencies. To remain open to traffic, structurally deficient bridges are often posted with reduced weight limits that restrict the gross weight of vehicles using the bridges. If unsafe conditions are identified during a physical inspection, the structure could be closed.

Bridges are considered “functionally obsolete” when the geometry of the roadway no longer meets today’s minimum design standards for either width or vertical clearance for that roadway classification. A functionally obsolete bridge is one that was built to standards that are not used today. Functionally obsolete bridges are those that do not have adequate lane widths, shoulder widths, or vertical clearances to serve current traffic demand, or those that may be occasionally flooded.

As discussed in Appendix A – Engineering Reliability Analysis, the Bourne Bridge is both structurally deficient and functionally obsolete. Using the Federal Highway Administration’s National Highway Bridge Inventory Ratings outlined in

Figure D - 6, the deck is in fair condition with a condition rating of 5. The superstructure is in poor condition with a condition rating of 4, and the substructure is in good condition with a condition rating of 7.

The Sagamore Bridge is functionally obsolete. The deck, superstructure, and substructure are in fair condition with condition ratings of 5.

More details on the current bridge conditions can be found in Appendix A – Engineering Reliability Analysis.

Table D - 6: Federal Highway Administration's National Bridge Inventory Condition Ratings

Code	Description	Commonly Employed Feasible Actions
9	EXCELLENT CONDITION	Preventive Maintenance
8	VERY GOOD CONDITION No problems noted.	
7	GOOD CONDITION Some minor problems.	
6	SATISFACTORY CONDITION Structural elements show some minor deterioration.	Preventive Maintenance; and/or Repairs
5	FAIR CONDITION All primary structural elements are sound but may have some minor section loss, cracking, spalling or scour.	
4	POOR CONDITION Advanced section loss, deterioration, spalling or scour.	Rehabilitation or Replacement
3	SERIOUS CONDITION Loss of section, deterioration, spalling or scour have seriously affected primary structural components. Local failures are possible. Fatigue cracks in steel or shear cracks in concrete may be present.	
2	CRITICAL CONDITION Advanced deterioration of primary structural elements. Fatigue cracks in steel or shear cracks in concrete may be present or scour may have removed substructure support. Unless closely monitored the bridge may have to be closed until corrective action is taken.	
1	IMMINENT FAILURE CONDITION Major deterioration or section loss present in critical structural components or obvious vertical or horizontal movement affecting structure stability. Bridge is closed to traffic but corrective action may put back in light service.	
0	FAILED CONDITION Out of service - beyond corrective action.	

4.2 Future Without-Project Condition

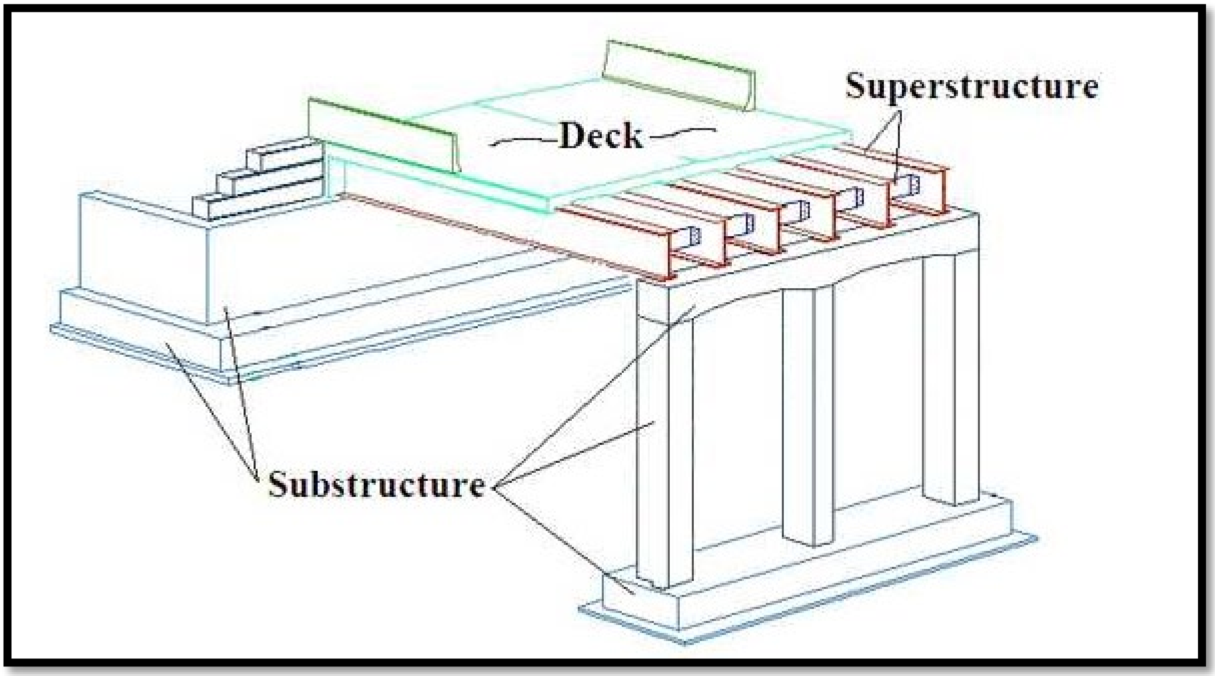
The future without-project condition outlines the condition in which there is no major rehabilitation or replacement of the existing bridges. It is assumed that continual, regularly-scheduled maintenance will be performed on the existing structures and emergency funds will be provided in the event of performance failure. Travel delays due to lane or bridge closures are expected during necessary maintenance and repair projects.

4.2.1 Probability of Unsatisfactory Performance

The three bridge components with potential for unsatisfactory performance (or failure) on the Cape Cod bridges include the bridge deck, the substructure, and the superstructure.

- Bridge deck is the section on the bridge that traffic travels on
- Superstructure is the section of the bridge that supports the bridge deck and connects the substructure components
- Substructure is the section of the bridge that supports the superstructure and distributes the loads to below-ground footings[ii]

Figure D - 3: Bridge Components



Source: The Michigan Department of Transportation (http://www.michigan.gov/mdot/0,4616,7-151-9618_47418-173584--,00.html)

Probability of unsatisfactory performance (PUP) functions exhibit instantaneous probabilities of components not performing as designed. PUP functions are related to age or number of operations. Unsatisfactory performance must also have measurable consequences. The PUP functions are determined during engineering reliability analysis through expert elicitation. For a more detailed description of the consequences of unsatisfactory performance please refer to Appendix A – Engineering Reliability Analysis.[iii]

For this study, unsatisfactory performance is defined as the physical condition where any of the bridges' critical elements is assigned a Condition Rating of 4 (Poor Condition) or less in accordance with protocols of the Federal Highway Administration's (FHWA) National Bridge Inventory (NBI). The NBI contains data reported annually to the FHWA by each state. Each of these bridge features is given a rating between 0 and 9 when inspected, with 9 signifying the best condition and a condition rating of 4 or less considered structurally deficient. A structurally deficient bridge requires maintenance and repair. Below are charts depicting probability of unsatisfactory or failure curves of the three components.

Figure D - 4: Base Condition Probability of a Bridge Deck Failure

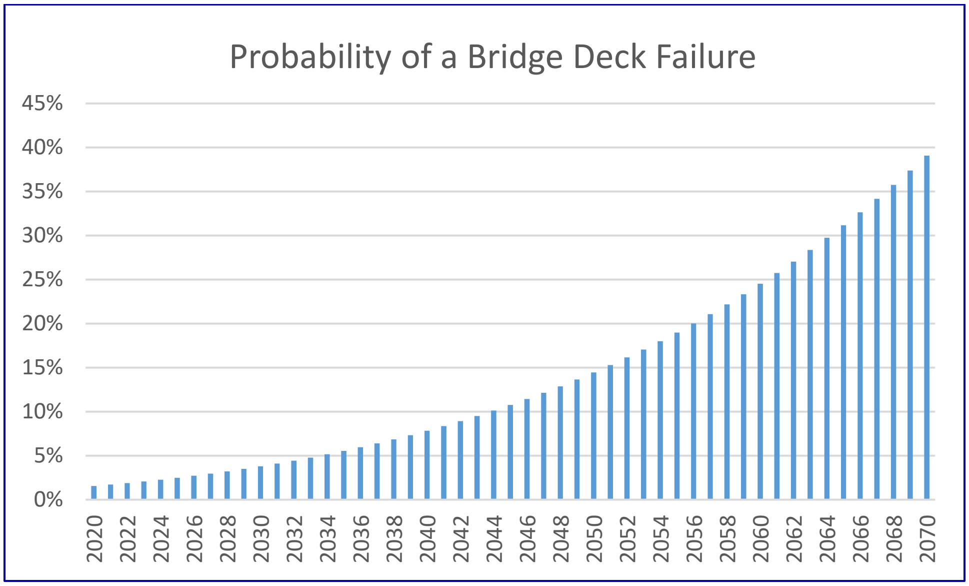


Figure D - 4 displays the bridge deck failure rate over time. The probability of failure is 1.6% in 2020 and if no major repairs are conducted, the probability of failure increases to 37.4% in 2069.

Figure D - 5: Base Condition Probability of a Substructure Failure

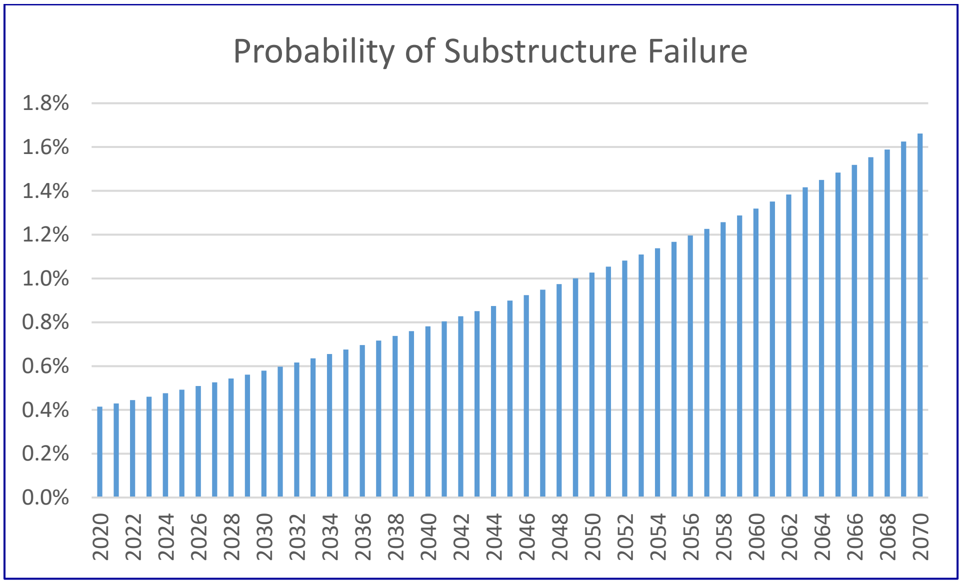


Figure D - 5 displays the substructure failure rate overtime. The probability of failure is 0.4% in 2020 and increases to 1.6% in 2069.

Figure D - 6: Base Condition Probability of a Superstructure Failure

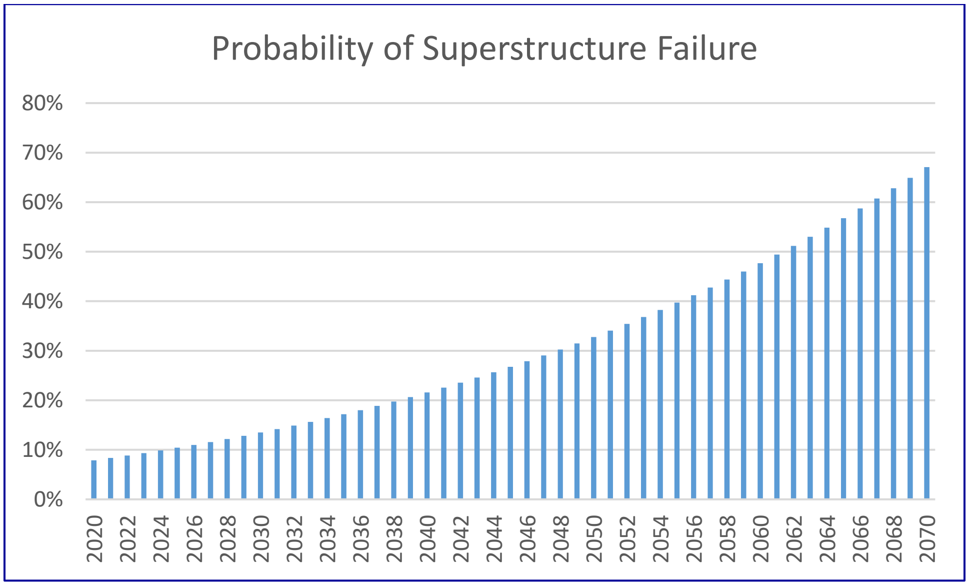


Figure D - 6 displays the superstructure failure rate overtime. The probability of failure is 7.9% in 2020 and increases to 64.9% in 2069.

4.2.2 Probabilistic Scenario Analysis

Engineering reliability must be integrated with economic costs to ensure that impacts related to all possible consequences are accurate for final cost-benefit analysis. Event trees are the primary tool used to identify and estimate risk. A logical progression of events flows through the depiction beginning with an initiating event and continuing through a set of outcomes. Probabilities and consequences are assigned to each possible outcome of an event. Outcomes are mutually exclusive and collectively exhaustive. Probabilities of an event must be between 0 and 1 and will sum to 1 for each node.[iv]

For this study, event trees were designed to predict individual component performance (see Appendix A for detailed engineering reliability analysis). The three bridge components (superstructure, bridge deck, and substructure) were further evaluated for which failures could trigger significant or catastrophic rehabilitation or replacement costs. The failures are described as: bridge deck deterioration, substructure deterioration, and superstructure deterioration. Probabilities of *localized* or *widespread* deterioration of each were created through engineering reliability analysis. Resulting action to restore performance from each deterioration scenario is also evaluated. Costs of these repair or replacement scenarios are included in the event tree. For each construction scenario there are additional expected traffic delays due to lane or bridge closures. Costs for closures were calculated (see: traffic analysis Section 3.3) and incorporated into the event tree. The resulting end nodes depict the probability of each event and the total cost which includes the rehabilitation cost and travel delay costs. Event trees were created for each bridge: the Sagamore Bridge and the Bourne Bridge, as well as for each engineering component. The event trees were modeled using Palisade PrecisionTree software and are presented in the following sections.

A rating of 4 or below may trigger the need for a repair, however, the year in which costs are allocated and when the repair work is completed can vary depending a variety of factors including severity and budgetary constraints. If the “failure” is minimal the repair work could take several years for funding to be approved and construction to begin. For more severe failures, emergency funds could be approved and implemented more quickly. A detailed description of the current and historical ratings of the bridge components can be found in Appendix A-Engineering Reliability, section 4.

Given the uncertainty and complexity of predicting when funds and repairs will occur, the economic modeling assumes costs and improvements are triggered in the same year as the component failure. This assumption could overestimate minor failure costs if those were to be delayed for several years as costs are discounted in future years. The impact will not be significant and will not change the final recommendation of this report.

Table D - 7 below summarizes the component failures and the impacts to traffic.

Table D - 7: Component Failure Impacts

Component and Failure Description	Cost to Repair ($000) Sagamore Bridge	Cost to Repair ($000) Bourne Bridge	Traffic Impact	Traffic Cost in 2020 ($000) Sagamore Bridge	Traffic Cost in 2020 ($000) Bourne Bridge
Superstructure					
Advanced deterioration of secondary member, non-critical Gusset Plate, Stringer, Floorbeam, or Hanger Cable	$6,600	$6,200	9 months lane closure - no closures Memorial Day to Columbus Day	$32,700	$21,100
Advanced deterioration of Main Truss Member or Critical Gusset Plate	$15,300	$20,200	18 months lane closures, divert trucks over 16 ton to sister bridge for 12 months	$321,200	$186,200
Catastrophic Damage to Main Truss Member or Critical Gusset Plate	$310,300	$547,700	60 months bridge Closure	$10,343,400	$4,584,000
Substructure					
Localized Concrete Defects such as Cracks or Spalls on Vertical Surfaces of Piers or Degradation of Concrete under Bearings on the Piers	$368	$526	6 months of lane closures, no closures Memorial Day to Columbus Day, lane closures limited to non-peak hours, weekdays	$18,300	$13,400
Widespread Concrete Defects such as Cracks or Spalls on Vertical Surfaces of Piers or Degradation on Concrete under Bearings on the Piers	$737	$1,053	12 months of lane closures, no closures Memorial Day to Columbus Day, Lane Closures limited to non-peak hours, weekdays	$36,600	$26,700
Bridge Deck					
Localized deterioration of Roadway Joint(s), Granite Curbs, Concrete-filled Steel Grid over Bridge Spans, or Reinforced Concrete Deck at Abutments	$5,100	$5,800	6 months of temporary lane closures, no closures Memorial Day to Columbus Day	$21,800	$14,100
Widespread Deterioration of Concrete-filled Steel Grid Deck over Bridge Spans and Reinforced Concrete Deck at the Abutments	$5,900	$7,600	15 months of temporary lane closures, no closures Memorial Day to Columbus Day	$54,400	$35,200

4.2.3 Sagamore Bridge – Bridge Deck Deterioration

Figure D - 7 below depicts the Sagamore Bridge event tree for bridge deck deterioration. The hazard function provides a probability that the bridge will receive a rating of less than or equal to

4, signaling that there is a component failure. If a failure occurs, there is a probability of 0.8 that there is localized deterioration of the roadway joint(s), granite curbs, concrete-filled steel grid over the bridge spans, or reinforced concrete deck at the abutments. This probability decreases to 0.55 in 2031 and beyond.

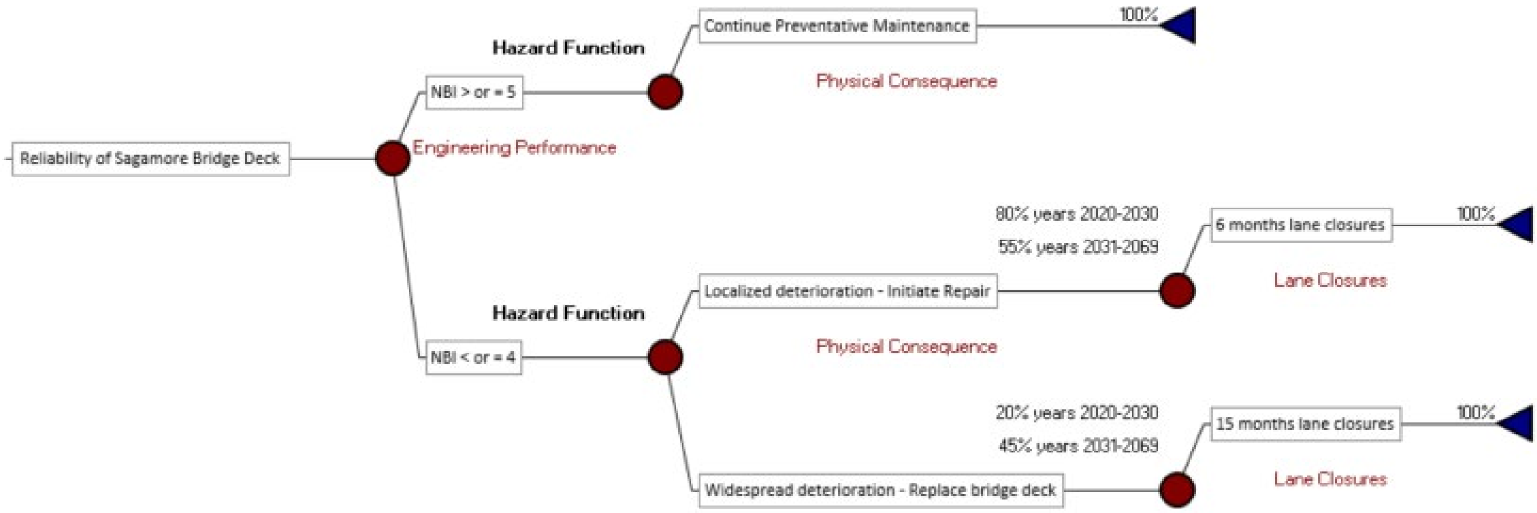
This failure scenario initiates a repair project to extend the life of the deficient component(s). Estimated construction costs for this action is $5.1 million. This repair results in 6 months of temporary lane closures on the Sagamore Bridge with no lane closures Memorial Day to Columbus Day triggering a time value cost from traffic delay of $21.8 million in 2020 and will increase over time.

If the bridge is rated at or below 4 under the NBI rating system, there is a probability of 0.2 of widespread deterioration of concrete-filled steel grid deck over bridge spans and reinforced concrete deck at the abutments. This probability increases to 0.45 beyond 2031. In this scenario, a repair project is initiated to replace the bridge deck at a cost of $5.9 million. This repair will require 15 months of temporary lane closures on the Sagamore Bridge with no closures from Memorial Day to Columbus Day at a traffic delay cost of $54.4 million in 2020 and increasing overtime.

4.2.4 Sagamore Bridge – Substructure Deterioration

Figure D - 8 depicts the Sagamore Bridge event tree for substructure deterioration. The hazard function provides a probability that the bridge will receive a rating of less than or equal to 4, signaling that there is a component failure. If a failure occurs there is a probability of 0.9 that there is localized concrete defects such as cracks or spalls on vertical surfaces of piers or degradation of concrete under bearings on the piers. This would initiate a repair project to extend the life of the deficient component(s). Estimated construction costs for this action are $368,000. This repair would result in 6 months of temporary lane closures on the Sagamore Bridge with no lane closures Memorial Day to Columbus Day, lane closures will be limited to Monday through Friday during non-peak hours as well as 14 day closure or delay to marine vessels. This results in a time value cost from traffic delay of $18.3 million in 2020 and $78,400 in navigation costs.

Figure D - 7: Sagamore Bridge Deck Deterioration Event Tree



If the bridge is rated at or below 4 under the NBI rating system, there is a probability of 0.1 of widespread deterioration of defects such as cracks and spalls on vertical surfaces of piers or degradation of concrete under bearings on the piers. In this scenario, a repair project is initiated to extend the service life of the deficient component(s) at a cost of $737,000. This will require 12 months of temporary lane closures on the Sagamore Bridge with no closures from Memorial Day to Columbus Day, lane closures are limited to Monday through Friday during non-peak hours, as well as 28 day closure or delay to marine vessels. This comes at a traffic delay cost of $36.6 million in 2020 and $156,800 in navigation costs.

4.2.1 Sagamore Bridge – Superstructure Deterioration

Figure D - 9 depicts the Sagamore Bridge event tree for superstructure deterioration. The hazard function provides a probability that the bridge will receive a rating of less than or equal to 4, signaling that there is a component failure. If a failure occurs there is a probability of 0.9 between 2020 to 2030 and 0.70 in years 2031 and beyond that there is advanced deterioration of secondary member, non-critical gusset plate, stringer, floorbeam, or hanger cable. This would initiate a repair project to extend the life of the deficient component(s). Estimated construction costs for this action is $6.6 million. This repair would result in 9 months of temporary lane closures on the Sagamore Bridge with no lane closures Memorial Day to Columbus Day. This results in a time value cost from traffic delay of $32.6 million in 2020.

If the bridge is rated at or below 4 under the NBI rating system, there is a probability of 0.0999 of advanced deterioration of main truss member or critical gusset plate from 2020 to 2030 and a probability 0.299 for the same occurrence in years 2031 and beyond. In this scenario, a repair project is initiated to extend the service life of deficient component(s) at a cost of $15.3 million and there will be temporary load restriction of 16 tons until corrective action is taken. Trucks will be diverted to the Bourne Bridge. This will require 18 months of temporary lane closures on the Sagamore Bridge with 12 months of restrictive load postings at a total cost of $321.2 million in 2020.

Finally, if the bridge is deemed in poor condition, there is a probability of 0.0001 of catastrophic damage to the main truss member or critical gusset plate in years 2020 to 2030 and 0.001 in years 2031 and beyond. This will result in permanent closure of the Sagamore Bridge to initiate construction of a new bridge at a total cost of $310.3 million. Traffic will be delayed for 60 months for design and construction of the new bridge at a total travel cost of $10.3 billion in 2020 and navigation costs of $168,000 due to 30 days of closures to the canal.

Figure D - 8: Sagamore Bridge Substructure Deterioration Event Tree

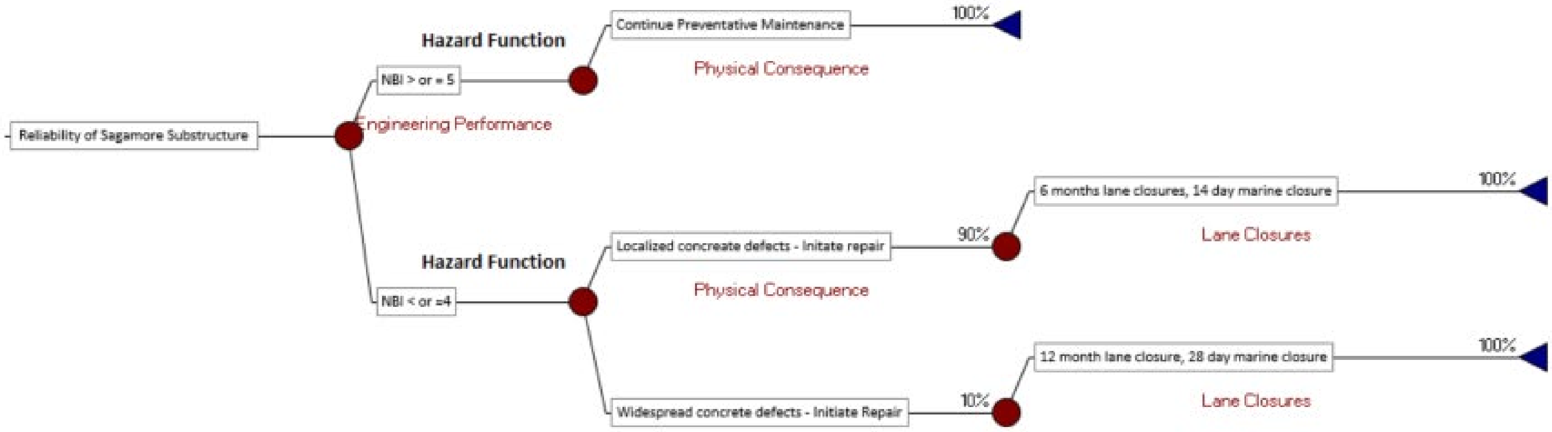
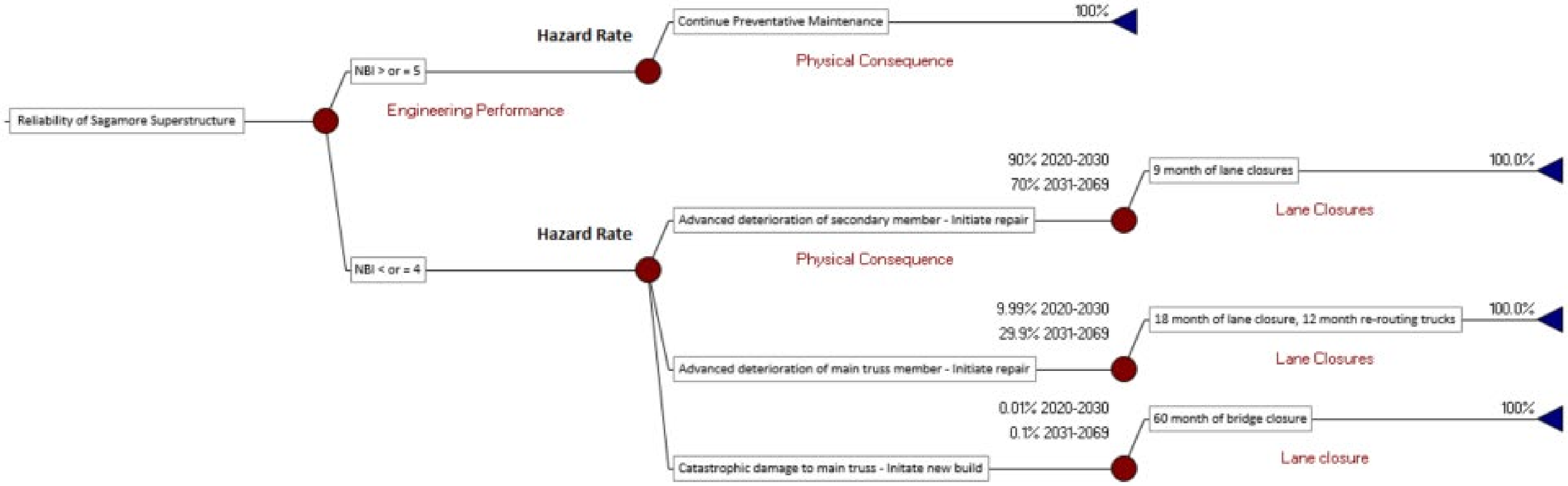

Reliability of Sagamore Substructure
Engineering Performance
Hazard Function
NBI > or = 5
Continue Preventative Maintenance
100%
Physical Consequence
Hazard Function
NBI < or =4
Localized concreate defects - Initate repair
90%
Physical Consequence
6 months lane closures, 14 day marine closure
100%
Lane Closures
Widespread concrete defects - Initiate Repair
10%
12 month lane closure, 28 day marine closure
100%
Lane Closures

Figure D - 9: Sagamore Superstructure Deterioration Event Tree


Reliability of Sagamore Superstructure
NBI > or = 5
Engineering Performance
Hazard Rate
Continue Preventative Maintenance
Physical Consequence
100%
NBI < or = 4
Hazard Rate
Advanced deterioration of secondary member - Initiate repair
Physical Consequence
90% 2020-2030
70% 2031-2069
9 month of lane closures
Lane Closures
100.0%
Advanced deterioration of main truss member - Initiate repair
9.99% 2020-2030
29.9% 2031-2069
18 month of lane closure, 12 month re-routing trucks
Lane Closures
100.0%
Catastrophic damage to main truss - Initate new build
0.01% 2020-2030
0.1% 2031-2069
60 month of bridge closure
Lane closure
100%

4.2.2 Bourne Bridge Deck Deterioration

Figure D - 10 below depicts the Bourne Bridge event tree for bridge deck deterioration. The hazard function provides a probability that the bridge will receive a rating of less than or equal to 4, signaling that there is a component failure. If a failure occurs there is a probability of 0.8 that there is localized deterioration of the roadway joint(s), granite curbs, concrete-filled steel grid over the bridge spans, or reinforced concrete deck at the abutments. The probability decreases to 0.55 in 2031 and beyond. This would initiate a repair project to extend the life of the deficient component(s). Estimated construction costs for this action is a cost of $5.8 million. This repair would result in 6 months of temporary lane closures on the Bourne Bridge with no lane closures Memorial Day to Columbus Day resulting and a time value cost from traffic delay of $14.1 million in 2020 and increasing over time.

If the bridge is rated at or below 4 under the NBI rating system, there is a probability of 0.2 of widespread deterioration of concrete-filled steel grid deck over bridge spans and reinforced concrete deck at the abutments. This probability increases to 0.45 in 2031 and beyond. In this scenario, a repair project is initiated to replace the damaged section of the bridge deck at a cost of $7.6 million. This repair will require 15 months of temporary lane closures on the Bourne Bridge with no closures from Memorial Day to Columbus Day at a traffic delay cost of $35.2 million in 2020 and increasing through 2069.

4.2.3 Bourne Bridge – Substructure Deterioration

Figure D - 11 depicts the Bourne Bridge event tree for substructure deterioration. The hazard function provides a probability that the bridge will receive a rating of less than or equal to 4, signaling that there is a component failure. If a failure occurs there is a probability of 0.9 that there is localized concrete defects such as cracks or spalls on vertical surfaces of piers or degradation of concrete under bearings on the piers. This would initiate a repair project with estimated construction costs of $526,000. This repair would result in 6 months of temporary lane closures on the Bourne Bridge with no lane closures Memorial Day to Columbus Day, lane closures will be limited to Monday through Friday during non-peak hours as well as 14 day closure or delay to marine vessels. This results in a time value cost from traffic delay of $13.4 million in 2020 and $78,400 in navigation costs.

If the bridge is rated at or below 4 under the NBI rating system, there is a probability of 0.1 of widespread deterioration of defects such as cracks and spalls on vertical surfaces of piers or degradation of concrete under bearings on the piers. In this scenario, a repair project is initiated to extend the service life of the deficient component(s) at a cost of $1.1 million. This will require 12 months of temporary lane closures on the Bourne Bridge with no closures from Memorial Day to Columbus Day, lane closures are limited to Monday through Friday during non-peak hours, as well as 28 day closure or delay to marine vessels. This comes at a traffic delay cost of $26.7 million in 2020 and $156,800 in navigation costs.

Figure D - 10: Bourne Bridge Deck Deterioration Event Tree

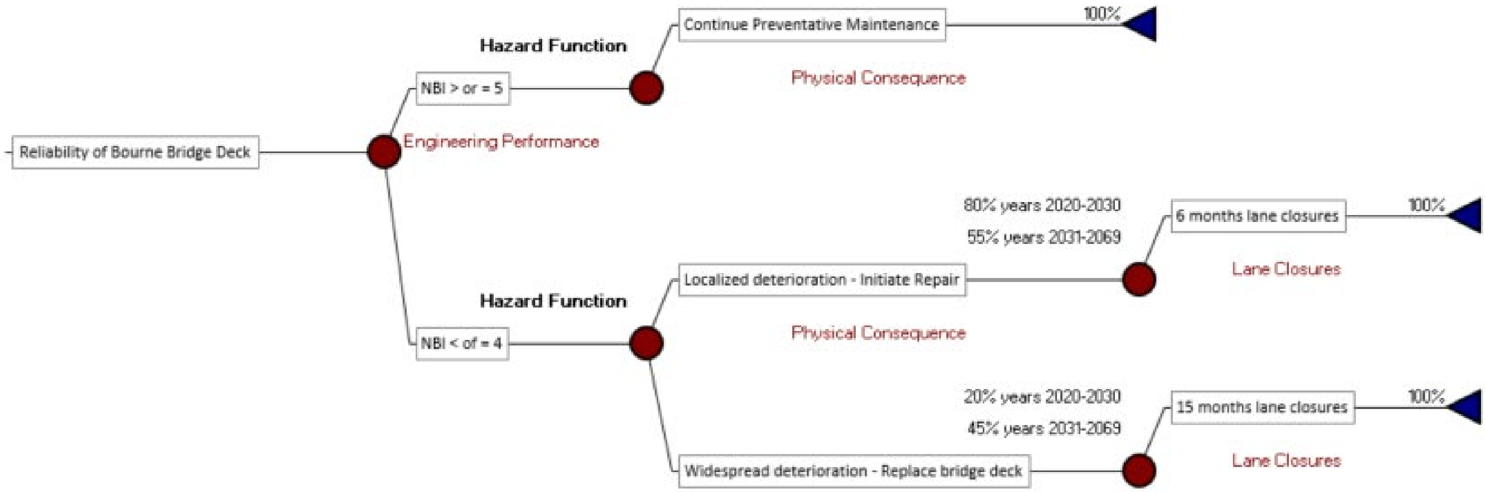
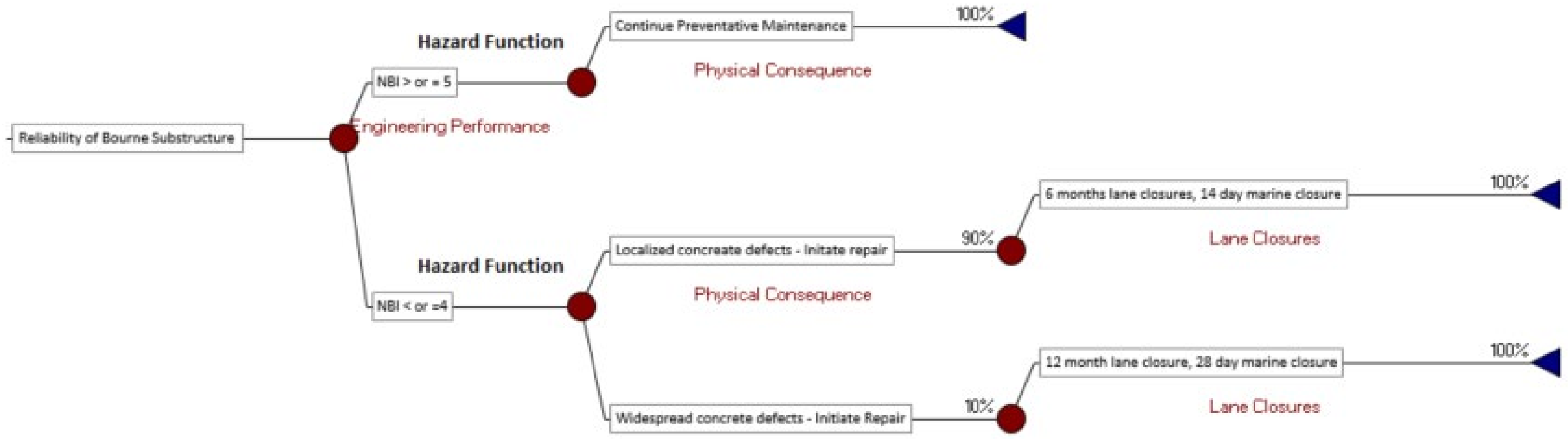


Figure D - 11: Bourne Bridge Substructure Deterioration Event Tree


Reliability of Bourne Substructure
Engineering Performance
Hazard Function
NBI > or = 5
Continue Preventative Maintenance
Physical Consequence
100%
Hazard Function
NBI < or =4
Localized concreate defects - Initate repair
Physical Consequence
90%
6 months lane closures, 14 day marine closure
Lane Closures
100%
Widespread concrete defects - Initiate Repair
10%
12 month lane closure, 28 day marine closure
Lane Closures
100%

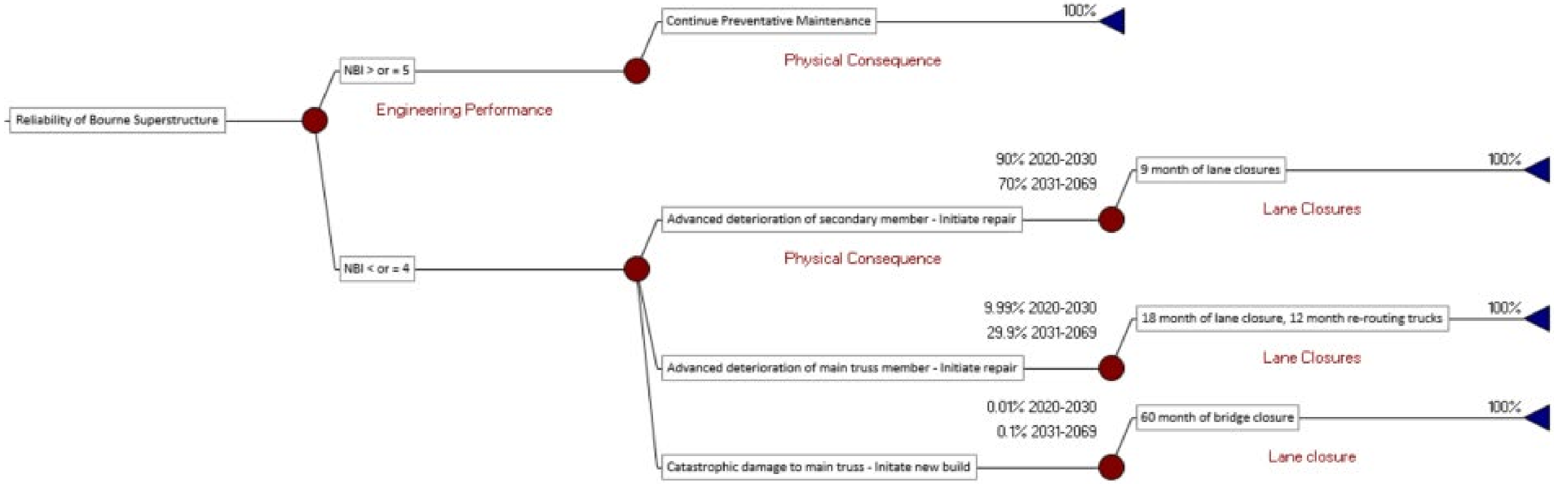
4.2.4 Bourne Bridge – Superstructure Deterioration

Figure D - 12 below depicts the Bourne Bridge event tree for superstructure deterioration. The hazard function provides a probability that the bridge will receive a rating of less than or equal to 4, signaling that there is a component failure. If a failure occurs there is a probability of 0.9 in years 2020 to 2030 and 0.70 in years 2031 and beyond that there is advanced deterioration of secondary member, non-critical gusset plate, stringer, floorbeam, or hanger cable. This would initiate a repair project with estimated construction costs of $6.2 million. This repair would result in 9 months of temporary lane closures on the Sagamore Bridge with no lane closures Memorial Day to Columbus Day. This results in a time value cost from traffic delay of $21.1 million in 2020.

If the bridge is rated at or below 4 under the NBI rating system, there is a probability of 0.0999 of advanced deterioration of main truss member or critical gusset plate from 2020 to 2030 and a probability 0.299 for the same occurrence in years 2031 and beyond. In this scenario, a repair project is initiated at a cost of $20.2 million and there will be temporary load restriction of 16 tons until corrective action is taken. Trucks will be diverted to Bourne Bridge. This will require 18 months of temporary lane closures on the Bourne Bridge with 12 months of restrictive load postings at a total cost of $186.2 million in 2020.

Finally, if the bridge is deemed in poor condition, there is a probability of 0.0001 of catastrophic damage to the main truss member or critical gusset plate in years 2020 to 2030 and 0.001 in years 2031 and beyond. This will result in permanent closure of the Bourne Bridge to initiate construction of a new bridge at a total cost of $547.7 million. Traffic will be delayed for 60 months for design and construction of the new bridge at a total travel cost of $4.6 billion in 2020 and navigation costs of $168,000 for 30 days of closures to the canal.

Figure D - 12: Bourne Superstructure Deterioration Event Tree


Reliability of Bourne Superstructure
NBI > or = 5
Engineering Performance
NBI < or = 4
Continue Preventative Maintenance
Physical Consequence
100%
Advanced deterioration of secondary member - Initiate repair
Physical Consequence
90% 2020-2030
70% 2031-2069
9 month of lane closures
Lane Closures
100%
Advanced deterioration of main truss member - Initiate repair
9.99% 2020-2030
29.9% 2031-2069
18 month of lane closure, 12 month re-routing trucks
Lane Closures
100%
Catastrophic damage to main truss - Initate new build
0.01% 2020-2030
0.1% 2031-2069
60 month of bridge closure
Lane closure
100%

4.3 Traffic Analysis

The Sagamore and Bourne Bridges provide the only access to Cape Cod for travelers in automobiles. Therefore traffic restrictions during construction projects will likely disrupt the local economy. Lane or total bridge closures are required when construction is performed on one or both of the bridges. This occurs in the event of emergency maintenance after a component failure. Commuters and travelers over the bridges will experience a loss of time due to traffic delays. Following Guidance from ER 1105-2-100 Appendix D, Table D-4; a value is determined for this loss of time incurred.

4.3.1 Traffic Data Collection

The Massachusetts Department of Transportation (MassDOT) is conducting a Cape Cod Canal Transportation Study to examine current traffic conditions in the area surrounding the Sagamore and Bourne Bridges. The Army Corps of Engineers worked with a contractor, TrafInfo, to collect this data for existing traffic conditions (2014) and future conditions (2040) matching the MassDOT framework. TrafInfo designed a regional travel demand model using TransCAD, a modeling software which simulates traffic volumes at various times of the day in the existing and future conditions with partial lane closures and full bridge closures.

The study area of the traffic analysis is comprised of the Bourne and Sagamore Bridges as well as the seven major connecting routes. More specifically, the routes which are depicted in Figure D - 13, include:

Between Bridges (East to West)

- Scenic Highway (Route 6): from Route 28 on/off ramps to Route 3 (where Route 6 and Route 3 merge to go over the Sagamore bridge), both directions
- Sandwich Road: from Bourne Rotary (the intersection between Sandwich Road and Route 28) to Route 6 ramps, both directions

North Bourne Rotary (Belmont Circle)

- Buzzards Bay Bypass (Route 6 and 28): from Glen Charlie Road in Wareham to the Route 28 on-ramp, eastbound

Bourne Bridge Entrances

- Route 25: From Exit 2 on Route 25 (Glen Charlie Road in Wareham) to the entrance of the Bourne Bridge, southbound
- Route 28: From Route 151 (Nathan Ellis Highway in Falmouth) to the entrance of the Bourne Bridge, northbound

Bourne Bridge

- The bridge itself south and northbound

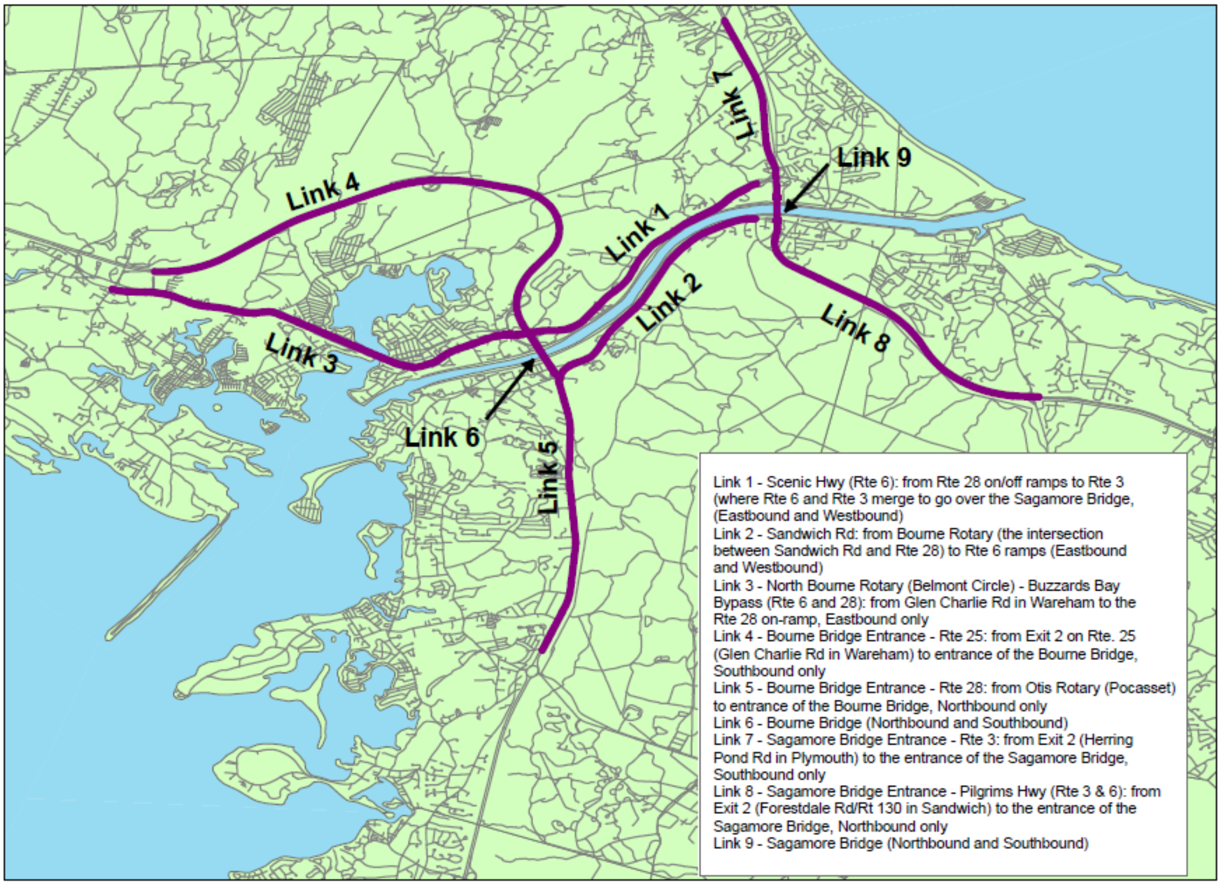
Sagamore Bridge Entrances

- Route 3: from Exit 2 (Herring Pond Road in Plymouth) to the entrance of the Sagamore Bridge, southbound
- Pilgrims Highway (Route 3 and 6): from Exit 2 (Forestdale Road/Route 130 in Sandwich) to the entrance of the Sagamore, northbound

Sagamore Bridge

- The bridge itself, south and northbound

Figure D - 13: Traffic Routes


Link 7
Link 9
Link 4
Link 1
Link 2
Link 8
Link 3
Link 6
Link 5
Link 1 - Scenic Hwy (Rte 6): from Rte 28 on/off ramps to Rte 3 (where Rte 6 and Rte 3 merge to go over the Sagamore Bridge, (Eastbound and Westbound)
Link 2 - Sandwich Rd: from Bourne Rotary (the intersection between Sandwich Rd and Rte 28) to Rte 6 ramps (Eastbound and Westbound)
Link 3 - North Bourne Rotary (Belmont Circle) - Buzzards Bay Bypass (Rte 6 and 28): from Glen Charlie Rd in Wareham to the Rte 28 on-ramp, Eastbound only
Link 4 - Bourne Bridge Entrance - Rte 25: from Exit 2 on Rte. 25 (Glen Charlie Rd in Wareham) to entrance of the Bourne Bridge, Southbound only
Link 5 - Bourne Bridge Entrance - Rte 28: from Otis Rotary (Pocasset) to entrance of the Bourne Bridge, Northbound only
Link 6 - Bourne Bridge (Northbound and Southbound)
Link 7 - Sagamore Bridge Entrance - Rte 3: from Exit 2 (Herring Pond Rd in Plymouth) to the entrance of the Sagamore Bridge, Southbound only
Link 8 - Sagamore Bridge Entrance - Pilgrims Hwy (Rte 3 & 6): from Exit 2 (Forestdale Rd/Rt 130 in Sandwich) to the entrance of the Sagamore Bridge, Northbound only
Link 9 - Sagamore Bridge (Northbound and Southbound)

Data was extracted for weekdays (WD) and weekends (WE) for three seasons- summer, fall and winter during four daily time periods-morning (6AM-9AM; called AM), mid-day (9AM-3PM; called MD), afternoon (3PM-6PM; called PM) and night time (6PM-6AM; called NT). The model was run and data extracted under the conditions that there are full and partial lane closures for the Sagamore Bridge with no restrictions for the Bourne Bridge and vice versa. By definition, *partial lane* closure is described as passage of vehicles in one lane in each direction (2 lanes total) over the bridge identified under repair. While, *full lane* closure constitutes no vehicular traffic passage (0 lanes total) on the bridge identified under repair. The term "Open" denotes no lane closures associated with rehabilitation activities.

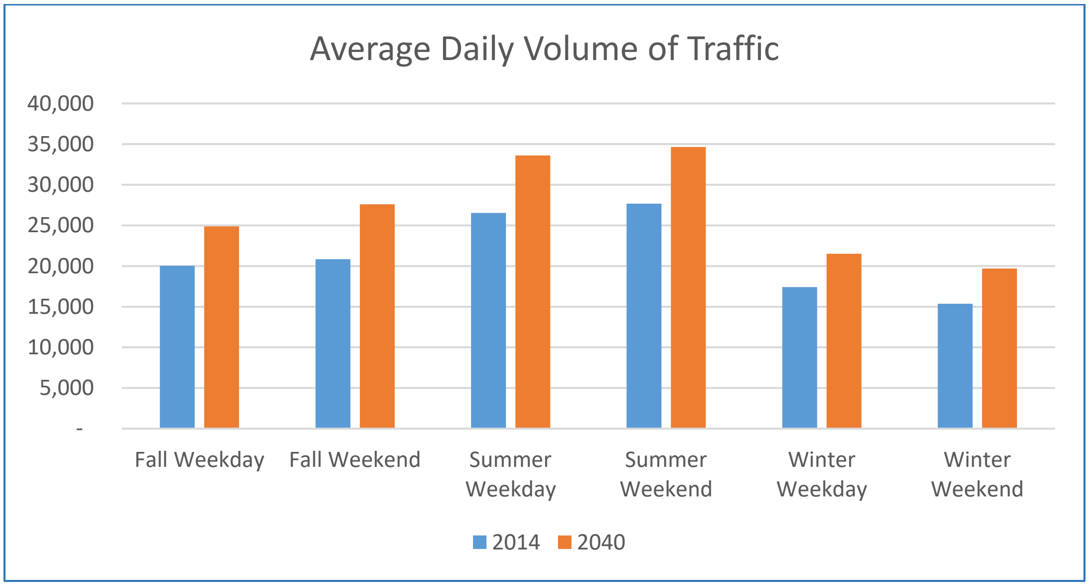
The original MassDOT Canal Transportation Study collected traffic data representative of summer and fall seasons, however TrafInfo modeled traffic conditions during the winter months (specifically January). Winter traffic modeling was calibrated using values input from existing data (MassDOT Canal Transportation Study and other data available through MassDOT's Traffic Collection Data Unit). Winter traffic volume and travel times were input for the four daily time periods, as well as weekends.

4.3.2 Conditions with No Traffic Impediments

Cape Cod is a vacation destination in the summer months, meaning the volume of traffic increases in the summer, particularly on weekends as visitors travel on and off the Cape.

Figure D - 14 displays the average daily traffic by season and day of the week (weekday or weekend). The volume of traffic is expected to increase over the forecast horizon and traffic will be at its maximum on summer weekends. Future traffic trends for visitors were projected based on data on employment trends in the Accommodations and Food Services and through discussions with the Cape Cod Commission. Future trends in non-visitor trips were escalated using population, household, and employment data.

Figure D - 14: Average Daily Volume of Traffic



Travelers over the Sagamore and Bourne bridges use 11 major routes. The 11 routes are:

1. From the mainland Route 3 to Cape Cod Route 6 via the Sagamore Bridge (2.8 miles)
2. From the mainland Route 25 to Cape Cod Route 6 via the Bourne Bridge (9.9 miles)
3. From the mainland Route 25 to Cape Cod Route 6 via the Sagamore Bridge (9.9 miles)
4. From the mainland Route 25 to Cape Cod Route 28 via the Bourne Bridge (6.9 miles)
5. From Cape Cod Route 28 to the mainland Route 25 via the Bourne Bridge (4.7 miles)

6. From Cape Cod Route 6 to the mainland Route 25 via the Sagamore Bridge (10.3 miles)
7. From Cape Cod Route 6 to the mainland Route 25 via the Bourne Bridge (7.4 miles)
8. From Cape Cod Route 6 to the mainland Route 3 via the Sagamore Bridge (4.2 miles)
9. From the mainland Belmont Circle to Cape Cod Route 6 via the Bourne Bridge (8.0 miles)
10. From the mainland Belmont Circle to Cape Cod Route 6 via the Sagamore Bridge (8.0 miles)
11. From the mainland Belmont Circle to Cape Cod Route 28 via the Bourne Bridge(5.0 miles)

The average travel time for a driver going over either the Sagamore Bridge or Bourne Bridge using one of the 11 routes described above is exhibited in Table D-7 below. Note that this includes only the length of the routes described (average 7.6 miles directly correlated to bridge traffic) not the total travel time drivers experience over their entire journey.

Table D - 8: Average Travel Time of Major Routes

Average Travel Time (Minutes)								
	Fall Weekday				Fall Weekend			
	AM	MD	PM	NT	AM	MD	PM	NT
Base Condition - 2014	9.5	9.0	9.8	8.9	9.1	9.2	9.6	8.9
Base Condition - 2040	9.9	9.1	10.4	9.0	9.3	9.5	10.6	9.2
	Summer Weekday				Summer Weekend			
	AM	MD	PM	NT	AM	MD	PM	NT
Base Condition - 2014	9.8	9.5	10.2	9.0	10.0	15.2	14.7	9.3
Base Condition - 2040	10.5	10.1	11.4	9.4	10.7	19.2	19.5	10.3
	Winter Weekday				Winter Weekend			
	AM	MD	PM	NT	AM	MD	PM	NT
Base Condition - 2014	9.7	8.9	9.5	8.8	8.9	9.0	9.1	8.8
Base Condition - 2040	10.1	8.9	9.9	8.9	9.0	9.0	9.4	8.9

MD = midday; NT = night time
Weekend=Saturday and Sunday

4.3.3 Value of Time with Traffic Impediments

The data collected and modeled by TrafInfo is used to determine the value of time due to traffic delays. The event trees described in section 3.2 outline probabilities of unsatisfactory performance by bridge component. Associated with each unsatisfactory performance is a resulting repair project to restore performance. The repair projects require lane or total bridge closures. Therefore the value of time for individuals adversely affected by traffic delays is determined by the amount of time bridges and lanes are closed. The procedure for this calculation follows guidance from USACE Engineering Regulation - ER 1105-2-100, Appendix D.

Outputs from TrafInfo Used in Risk Analysis Model

One output from Trafinfo that is an input into the risk model is Vehicle Hours Traveled (VHT) for all vehicles in a given time period by season and day of the week (weekday or weekend). VHT is also provided for the existing condition and for lane and full bridge closures of each bridge. The data is provided for year 2014 and a forecast year of 2040, intermediate values were linearly interpolated and years after 2040 were held constant. Values were held constant after 2040 to provide a conservative estimate of traffic growth and to prevent a forecast that could reflect traffic volumes higher than the maximum capacity of the road network.

VHT is also separated by the driver's trip purpose, either Visitor or Regular as defined by the State Planning Agency-Central Transportation Planning Staff (CTPS). Based on the 2010 Census Journey to Work and the Massachusetts Travel Survey, Visitor and Regular are defined as:

- Non-visitor or "Regular" – Trips by people who live on the Cape and commute to the mainland daily for work/school; trips by people who live on the mainland and commute to the Cape daily for work/school; trips by people who live on the Cape and travel across the bridge to the mainland to shop and other commercial activities on a regular basis; trips by people who live on the mainland and travel across the bridge to the Cape to shop and for other commercial activities on a regular basis.
- Visitor – all other travelers, they generally do not live or work on the Cape and do not otherwise cross the bridge on a regular daily basis.

The next traffic analysis input is the average travel time in minutes which is the travel time for a driver going over either the Sagamore Bridge or Bourne Bridge over the 11 major routes listed in section 3.3.2. Travel times vary depending on whether there is a partial bridge closure (one lane closed on either side) or full bridge closure (all lanes closed). The difference between lane or bridge closure and non-closure traffic is a key input in determining the value of time in traffic. TrafInfo provided these travel times for years 2014 and 2040, linear interpolation was used for years 2015-2039 and held constant for years 2040-2069. Again, values were held constant after 2040 to provide a conservative estimate of traffic growth and to prevent a forecast that could reflect traffic volumes higher than the maximum capacity of the road network.

Table D - 9: Average Travel Time by Closure 2014

Average Travel Time in 2014 (Minutes)						
	Fall		Summer		Winter	
Alternatives	**Weekday**	**Weekend**	**Weekday**	**Weekend**	**Weekday**	**Weekend**
Existing Hwy	9.3	9.2	9.6	12.3	9.3	9.0
Partial Bourne	12.3	12.3	14.5	25.5	12.1	10.3
Full Bourne	16.6	15.7	20.8	37.0	16.3	13.0
Partial Sagamore	9.8	9.5	11.7	30.5	9.9	9.0
Full Sagamore	19.1	18.5	40.0	77.6	18.0	12.5
Difference (min)						
Alternatives	**Weekday**	**Weekend**	**Weekday**	**Weekend**	**Weekday**	**Weekend**
Existing Hwy	-	-	-	-	-	-
Partial Bourne	3.0	3.1	4.9	13.2	2.8	1.4
Full Bourne	7.3	6.5	11.2	24.8	7.1	4.0
Partial Sagamore	0.5	0.3	2.1	18.2	0.6	0.0
Full Sagamore	9.8	9.3	30.4	65.3	8.7	3.5

Table D - 10: Average Travel Time by Closure 2040

Average Travel Time in 2040 (Minutes)						
	Fall		Summer		Winter	
Alternatives	**Weekday**	**Weekend**	**Weekday**	**Weekend**	**Weekday**	**Weekend**
Existing Hwy	9.6	9.6	10.3	14.9	9.5	9.1
Partial Bourne	15.8	23.5	61.8	85.2	21.9	11.4
Full Bourne	25.2	26.2	53.5	76.1	27.4	16.6
Partial Sagamore	31.5	32.3	85.3	106.2	31.2	10.8
Full Sagamore	47.8	58.8	125.6	177.2	59.8	29.6
Difference (min)						
Alternatives	**Weekday**	**Weekend**	**Weekday**	**Weekend**	**Weekday**	**Weekend**
Existing Hwy	-	-	-	-	-	-
Partial Bourne	6.2	13.9	51.5	70.3	12.4	2.4
Full Bourne	15.6	16.6	43.2	61.2	17.9	7.5
Partial Sagamore	21.9	22.7	75.0	91.3	21.7	1.7
Full Sagamore	38.2	49.2	115.3	162.2	50.4	20.5

Value of Time Inputs

The calculated dollar value of time is based on several inputs including: median family income, passengers per vehicle, and the reason for travel. Hourly annual income is calculated using the average annual household income sourced from the U.S. Census then divided by the number of weeks in the year (52 weeks per year) and by the hours worked in a week (assuming 40 hours per week).

- Median family income:
  - Visitors – used the Massachusetts average household income of $70,954 (in 2016 dollars), 2012-2016, sourced from the U.S. Census. [v]
  - Regulars – used the average household income of the towns surrounding Cape Cod: Bourne ($70,304), Sandwich ($89,461), Wareham ($65,641), and Plymouth ($80,905) for a total average of $76,578, sourced from the U.S. Census.
- Following the process described in ER 1105-2-100 (D-20), the total value of worked time saved per vehicle requires multiplication by the adults per car. According to the US Department of Transportation, 2001 National Household Travel Survey, average passengers per vehicle for work trips is 1.14.[vi] For social/recreation, vacation, and other trips, the value of time saved is on a per vehicle basis.
- Value of time saved adjusted to hourly basis (% of hourly family income of driver) from ER 1105-2-100 (D-20). Table D-10 summarizes the percent of hourly income used.

The following table from ER1105-2-100 was used as guidance:

Table D - 11: Percent of Hourly Income and Hourly Value of Time ($/hour)

	Massachusetts average hourly income ($/hour)	Average hourly income ($/hour) - Bourne, Sandwich, Wareham, Plymouth	Value of time saved % of hourly family income
Low time (0-5 min)			
Work Trips	$ 2.18	$ 2.36	6.4%
Soc/rec Trips	$ 0.44	$ 0.48	1.3%
Other Trips	$ 0.03	$ 0.04	0.1%
Medium time (5-15 min)			
Work Trips	$ 10.98	$ 11.85	32.2%
Soc/rec Trips	$ 7.88	$ 8.50	23.1%
Other Trips	$ 4.95	$ 5.34	14.5%
High time (over 15 mins)			
Work Trips	$ 18.35	$ 19.81	53.8%
Soc/rec Trips	$ 20.47	$ 22.09	60.0%
Other Trips	$ 22.00	$ 23.75	64.5%
Vacation			
All value of time	$ 25.62	$ 27.65	75.1%

Visitor value of time is the average of social/recreational trips, other trips, and vacation using the Massachusetts household income. "Other trips" include all trips not otherwise determined to be work, social/recreational, or vacation. Regular value of time was determined to be the average of social/recreational, other, and work (multiplied by 1.14 for occupancy) for the average of Bourne, Sandwich, Wareham, and Plymouth.

Using those calculations, the following value of time totals were determined (in 2016 dollars) at an hourly rate:

Table D - 12: Value of Time per Hour by Trip Type in 2016 Dollars

	Visitors	**Regulars**
Low	$ 8.70	$ 1.07
Medium	$ 12.82	$ 9.12
High	$ 22.70	$ 22.81

Travel time for vacation is a higher cost because there is a scarcity factor for the amount of vacation time households have and therefore the value of an hour of vacation time is higher than for work, social/recreation, and other trips. The regular travelers caught in relatively short traffic delays is pointedly lower because this time is not considered scarce.

The computed 2016 value of time is then converted into 2020 dollars using the implicit GDP deflator as forecasted by the President's budget office and presented in Table D - 13 below[vii].

Table D - 13: GDP Deflator

	2015	**2016**	**2017**	**2018**	**2019**	**2020**
Nominal GDP	$18,037	$18,566	$19,372	$20,262	$21,263	$22,345
Real GDP (2009 Dollars)	$16,397	$16,660	$17,090	$17,601	$18,157	$18,727
Implicit Deflator	1.10	1.11	1.13	1.15	1.17	1.19

Value of time in 2020 dollars:

Table D - 14: Value of Time per hour by Trip Type in 2020 Dollars

	Visitors	**Regulars**
Low	$ 9.31	$ 1.14
Medium	$ 13.72	$ 9.76
High	$ 24.30	$ 24.42

Value of Time Due to Traffic Delays

The following calculations were performed in order to determine the total travel costs incurred by drivers when there is a lane or bridge closure for construction repair.

1. *VHT_{delay} x VOT = Cost of Delay per Day (by day and season)*
2. *Cost of Delay per Day x Days of Closure = Total Travel Costs*
   - *VHT_{delay} = VHT with lane or bridge closure – VHT with no closure for all drivers (available by year, season, time of day, weekend/weekday, visitor/regular)*
   - *VOT = Value of time (uses the values determined in* Table D - 14 *above. The high/medium/low times categories are determined by taking the Travel Time with closures minus the Travel Time with no closures to determine the average delay.*
   - *Days of Closure – number of days during construction that there will be a lane or bridge closure which varies by project*

Table D - 15: Cost of Emergency Repairs

Component and Failure Description	**Traffic Impact**	**Cost in 2020 (000) Sagamore Bridge**	**Cost in 2020 (000) Bourne Bridge**
Superstructure			
Advanced deterioration of secondary member, non-critical Gusset Plate, Stringer, Floorbeam, or Hanger Cable	9 months lane closure - no closures Memorial Day to Columbus Day	$32,700	$21,100
Advanced deterioration of Main Truss Member or Critical Gusset Plate	18 months lane closures, divert trucks over 16 ton to sister bridge for 12 months *	$321,200	$186,200
Catastrophic Damage to Main Truss Member or Critical Gusset Plate	60 months bridge Closure	$10,343,400	$4,584,000
Substructure			
Localized Concrete Defects such as Cracks or Spalls on Vertical Surfaces of Piers or Degradation of Concrete under Bearings on the Piers	6 months of lane closures, no closures Memorial Day to Columbus Day, lane closures limited to non-peak hours, weekdays	$18,300	$13,400

Widespread Concrete Defects such as Cracks or Spalls on Vertical Surfaces of Piers or Degradation on Concrete under Bearings on the Piers	12 months of lane closures, no closures Memorial Day to Columbus Day, Lane Closures limited to non-peak hours, weekdays	$36,600	$26,700
Bridge Deck			
Localized deterioration of Roadway Joint(s), Granite Curbs, Concrete-filled Steel Grid over Bridge Spans, or Reinforced Concrete Deck at Abutments	6 months of temporary lane closures, no closures Memorial Day to Columbus Day	$21,800	$14,100
Widespread Deterioration of Concrete-filled Steel Grid Deck over Bridge Spans and Reinforced Concrete Deck at the Abutments	15 months of temporary lane closures, no closures Memorial Day to Columbus Day	$54,400	$35,200
* According to MassDOT trucks account for roughly 6% of traffic traveling over the bridges. Therefore 6% of traffic was rerouted as if full bridge closure for 12 months. Further detail provided in section 10.1.6.			

4.3.4 Vehicle Operational Costs

Additional travel costs incurred by delay are considered vehicle operational costs. Operational costs are expenditures spent on operating and maintaining a vehicle for additional usage. Costs include fuel, maintenance, repairs, and depreciation to vehicle value[viii]. Operating cost used in this model is $0.57 per mile; the 2016 cost of owning and operating an auto sourced from the American Automobile Association. The computed 2016 value of time is then converted into 2020 dollars using the implicit GDP deflator as forecasted by the President's budget office.

If there is a required full bridge closure to repair a component failure, commuters may need to travel further to the other canal bridge incurring additional mileage. The operational cost was determined by subtracting the Vehicle Miles Traveled (VMT) when there is no closure from the VMTs traveled when there is a closure to determine the additional miles traveled. These miles were multiplied by $0.57.

4.4 Impacts to Navigation

The Cape Cod Canal is a key transportation link for vessel traffic transiting the US east coast, between southern New England, New York, or points south, and Boston, northern New England, and points north. Without the canal, vessels would have to transit around the arm of Cape Cod, increasing vessel travel distances by approximately 60 nautical miles, an 18 percent increase for vessels traveling between New York and Boston. Each year the canal is used by more than

1,000 cargo vessels, at least 400 fishing vessels, 150 – 200 military vessels, and more than 4,000 recreational vessels, all of which benefit significantly from the shorter and safer travel route. Since its completion in 1914, the canal has greatly increased the efficiency of waterborne commerce shipments in the Northeast, contributing greatly to the national economy. The Canal also increases navigation safety. Prior to construction of the Canal, many shipwrecks occurred along the route around the Cape, since fog, shoals and exposure to bad weather are significantly worse in the areas off Cape compared to the interior. The navigation benefits provided by the canal are extremely important to the economies of Massachusetts, New Hampshire, and Maine, with critical shipments of petroleum products making up the majority of cargo traffic through the canal, and with vessels of all types benefiting from the shorter and safer transit route.

4.4.1 Vessel Trips

Canal Records

Records of vessel trips through the Cape Cod Canal are kept at the canal office. The data collected at the canal shows the number of vessels with a length of 65-feet or greater of various types, as well as estimates for the number of vessels under 65-feet. Table D - 16 below presents the wide range of vessel types and sizes of approximately 22,000 vessels that transited the canal between 2013 and 2018.

Table D - 16: Number of Vessels transiting Cape Cod Canal

Vessels Over 65 Feet in Length						
	2013	**2014**	**2015**	**2016**	**2017**	**2018**
Passenger, Dry Cargos	1,025	1,084	1,043	1,063	1,064	1,102
Tankers	55	34	15	39	49	68
Towing Vessels	3,191	3,407	3,242	3,293	3,057	3,225
Dry Cargos, Scows	384	330	294	308	238	265
Tanker Barges	1,302	1,270	1,225	1,249	1,259	1,334
Fishing Vessels	780	756	811	848	877	492
Yachts	684	680	726	665	695	720
Military Vessels	147	202	169	223	156	165
Others	90	83	145	210	88	74
TOTAL	**7,658**	**7,846**	**7,670**	**7,898**	**7,483**	**7,445**
Vessels Under 65 Feet in Length (Estimated)						
	2013	**2014**	**2015**	**2016**	**2017**	**2018**
Fishing Vessels	139	225	333	308	344	422
Pleasure Craft	4,205	4,458	5,580	7,304	7,380	7,911
Misc. Vessels	5,483	6,397	6,089	3,804	5,798	5,985
TOTAL	**9,827**	**11,080**	**12,002**	**11,416**	**13,522**	**14,318**

WCSC Cargo Records

The Army Corps of Engineers Waterborne Commerce Statistics Center (WCSC) publishes data showing vessel trips. The WCSC data reflects only cargo vessels, so the figures are not directly comparable to the vessel data collected at the canal office. However, both sets of data are valuable and so both are presented in this report to show the full usage of the Canal for navigation. From 2012 through 2017 (latest data available as of August 2019), foreign flag commercial cargo vessel trips peaked in 2013 with fewer trips in 2014 - 2017. Traffic on US-flag vessels declined at a compound annual rate of -2% over the six years, versus -30% for foreign traffic. Cargo vessel trips through the canal are shown in the table below.

Table D - 17: Cargo Vessel Trips 2012-2017

Cape Cod Canal Cargo Vessel Trips, 2012-2017									
Year	**Upbound Trips**			**Downbound Trips**			**Total Trips**		
	Foreign	**Domestic**	**Total**	**Foreign**	**Domestic**	**Total**	**Foreign**	**Domestic**	**Total**
2012	1,328	721	2,049	1,324	522	1,846	2,665	1,243	3,908
2013	1,693	868	2,561	1,739	513	2,252	3,432	1,381	4,813
2014	701	878	1,579	740	534	1,274	1,441	1,412	2,853
2015	107	804	911	179	528	707	286	1,332	1,618
2016	141	939	1,080	129	627	756	270	1,566	1,836
2017	168	683	851	140	441	581	308	1,124	1,432

4.4.2 Commodity Statistics

Types and Tonnage

WCSC publishes annual statistics showing commodity volumes and commercial cargo vessel trips to major ports, and through major waterways including the Cape Cod Canal. An average of 7,800,000 tons of cargo were shipped through the Canal annually between 2012 and 2017. Commodity shipments through the Canal have been dominated primarily by petroleum and petroleum products, which accounted for 83.9% of all freight tonnage in 2017. Chemicals were the next largest category at 11.6%, followed by primary manufactured goods at 2.8%. Together, these top three categories accounted for 98.3% of total freight tonnages in 2017, the most recent year for which WCSC data is available.

Petroleum and petroleum products shipped through the canal declined by a compound annual rate of 5.4% from 2012 to 2017, with a gain in the first year followed by large declines in 2014 and 2015 and finally a slight increase in 2016 before declining again in 2017. Chemical traffic increased annually in 2014, 2015, and 2016 before declining in 2017. Total freight traffic declined at a rate of 5.9% compounded annually from 2012 to 2017, with a drop-off starting in 2014 that was largely due to sluggish traffic in the petroleum segment. Cargo volumes through the canal for the past six years are shown in the table below.

Table D - 18: Cape Cod Freight Traffic, 2012-2017

Cape Cod Freight Traffic, 2012-2017												
	2012		**2013**		**2014**		**2015**		**2016**		**2017**	
Commodity	**Short tons**	**% total**	**Short tons**	**% total**	**Short tons**	**% total**	**Short tons**	**% total**	**Short tons**	**% total**	**Short tons**	**% total**
Petroleum & petroleum products	7,113,000	81.2%	8,657,000	85.3%	6,484,000	80.7%	5,365,000	77.2%	5,409,000	78.7%	5,097,000	83.9%
Chemicals	812,000	9.3%	743,000	7.3%	1,015,000	12.6%	1,119,000	16.1%	1,126,000	16.4%	703,000	11.6%
Crude materials	286,000	3.3%	155,000	1.5%	66,000	0.8%	49,000	0.7%	15,000	0.2%	39,000	0.6%
Primary manufactured goods	365,000	4.2%	394,000	3.9%	391,000	4.9%	355,000	5.1%	246,000	3.6%	168,000	2.8%
Food & farm products	2,000	0.0%	13,000	0.1%	6,000	0.1%	-	0.0%	-	0.0%	4,000	0.1%
Manufactured equipment & machinery	174,000	2.0%	141,000	1.4%	73,000	0.9%	63,000	0.9%	36,000	0.5%	63,000	1.0%
Coal	10,000	0.1%	45,000	0.4%	-	0.0%	-	0.0%	43,000	0.6%	-	0.0%
TOTAL	**8,762,000**	**100.0%**	**10,148,000**	**100.0%**	**8,035,000**	**100.0%**	**6,951,000**	**100.0%**	**6,875,000**	**100.0%**	**6,074,000**	**100.0%**

Source: US Army Corps of Engineers, Waterborne Commerce of the United States, 2012-2017

4.4.3 Origin/Destinations

Detailed vessel data was requested from the Corps Waterborne Commerce Statistics Center for the Cape Cod Canal for calendar year 2017, the most recent year available. The detailed data is confidential and cannot be presented in this report. However, aggregated information can be shown and used for calculations. The detailed data includes information for all US Flag cargo vessels which passed through the canal including port of origin, destination port, vessel name, owner, type of vessel, type of cargo, tonnage, draft, and other information. US flag vessels transported 89.7% of total cargo tons through the canal in 2017. The portion of cargo shipped on foreign flag vessels started to decline in 2014 and dropped significantly in 2015 before rising slightly in 2016 and 2017. The breakdown of cargo tonnages on US versus foreign flag vessels for 2012 through 2017 is shown in the table below.

Table D - 19: Cape Cod Canal Freight Traffic, 2012-2017

Cape Cod Canal Freight Traffic, 2012-2017

Year	Domestic Tons	Foreign Tons	Total Tons	% Domestic	% Foreign	Total %
2012	5,325,000	3,438,000	8,763,000	60.8%	39.2%	100.0%
2013	6,710,000	3,438,000	10,148,000	66.1%	33.9%	100.0%
2014	6,535,000	1,500,000	8,035,000	81.3%	18.7%	100.0%
2015	6,649,000	303,000	6,952,000	95.6%	4.4%	100.0%
2016	6,375,000	499,000	6,874,000	92.7%	7.3%	100.0%
2017	5,446,000	627,000	6,073,000	89.7%	10.3%	100.0%

Source: US Army Corps of Engineers, Waterborne Commerce of the United States, 2012-2017

An analysis of the detailed WCSC data shows that in 2017, 72% of domestic cargo vessel trips through the canal either originated in or had a destination of Boston Harbor. Of the trips which originated in Boston, 79% had a destination of the Port of New York/New Jersey. Of the trips which had a final destination of Boston Harbor, 67% originated at the Port of New York/New Jersey. Other ports in the northeast made up the remaining origins or destinations, including most commonly Providence, New Haven, Portland (Maine), Portsmouth, and Delaware. Cargo shipments through the canal reflected in the detailed WCSC data for 2017 were primarily on non-self-propelled dry cargo and tanker barges, pushed or pulled by towboats.

4.4.4 Methods

For this analysis, the navigation value of the canal is examined by comparing waterborne transportation costs between the without and with project conditions as is typical in Corps navigation analyses. Without the canal, vessels which currently use the canal would have to travel an average of 62 additional miles to reach their final destinations. The difference in waterborne transportation costs between the without and with canal conditions can be considered a partial measure of the value of the canal. The value of the canal can in turn be considered a partial measure of the value of the vehicle bridges, since construction of the canal was dependent on construction of the bridges. The cost of the longer travel distance without the canal can also be used to evaluate navigation impacts if bridge repairs require temporary closure of the canal, in the extreme case of a catastrophic failure and a new bridge must be constructed, that will also require canal closures.

4.4.5 Annual Navigation Benefits of the Canal

For this analysis, waterborne transportation costs in the without and with canal conditions are calculated for cargo vessels which transited the canal in 2017, using detailed WCSC data. The difference between the costs of the two conditions represents only a portion of the navigation value of the canal, since cargo vessels are only a portion of vessel traffic using the canal. However, detailed data on cargo vessel traffic is readily available from the Corps WCSC, and waterborne transportation cost savings can be calculated using standard Corps methods.

The elements that make up waterborne transportation costs include the number of trips, trip distance, vessel speed, and vessel costs per day. Since the cargo vessels which used the canal in 2016 were primarily barges and towboats with relatively shallow drafts, the Corps Shallow Draft Vessel Operating Costs were used for this analysis. Those costs were last updated and released by the Corps in November 2004, in Economic Guidance Memorandum 05-06, “Shallow Draft Vessel Operating Costs, Fiscal Year 2004.” Those costs were more recently revised and updated to the 2015 price level by Informa Economics, under contract to the Corps Center of Expertise for Inland Navigation. The price levels were then escalated to 2020 values using a GDP deflator in order to allow for comparability between all other costs in the analysis.

The shallow draft vessel operating costs for towboats include daily costs for various types and sizes of towboats, organized by the horsepower of the towboat. The costs for barges include daily operating costs for various types of barges, organized by the carrying capacity of the barge. It should be noted that the vessels represented in the cost tables are inland tow boats and barges, which are generally smaller than the coastal barges that operate between ports on the US east coast. The towboat and barge categories were matched to the best extent possible to vessels transiting through the Canal. Information regarding horsepower for specific towboats which used the canal was obtained from the WCSC publication, “Waterborne Transportation Lines of the United States, volume 3 – Vessel Characteristics, Calendar Year 2016.” Towboats transiting the Canal had an average horsepower of between 4,000 to 5,999. Based on the Informa Economics cost tables, average daily costs for towboats with a horsepower of 4,000 to 5,999 equal $20,290 per day under maximum fuel cost, and $13,680 per day under actual daily fuel cost. For this analysis, the actual daily fuel cost category was used.

Since more than 70% of US flag cargo vessel trips through the Canal in 2017 were between the ports of Boston and New York/New Jersey that travel distance is used as a representative trip distance for this analysis. Based on the nautical trip calculator available at www.sea-distances.org, the trip distance between New York and Boston without the Canal is 378 nautical miles. With the Canal, a trip distance of 316 nautical miles is used, a distance savings of 62 nautical miles. An average trip speed of 7.5 knots is estimated based on an analysis of trip durations in the detailed WCSC data.

Total waterborne transportation costs for cargo vessel traffic using the canal equal towboat costs plus barge costs. Annual barge costs were estimated separately for tanker barges and dry cargo barges. The costs were converted to 2020 values. The number of trips for each was determined using the detailed WCSC data. Daily operating costs were used for the barges which most closely matched the barges which transited the canal in 2017, to the extent possible. Liquid tanker barge transportation costs were calculated using costs of $1,672 per day for a 390’x70’x22’ tanker barge. Dry cargo barge transportation costs were calculated using a cost of $866 per day for a 360’x70’x21’ tanker barge. Costs for foreign flag vessel trips were not calculated because the WCSC detailed data for the canal did not include information for those vessels.

Based on the detailed WCSC data, there were 230 towboat trips through the canal and 894 barge trips (833 tanker barges and 61 dry cargo barges) under US flag vessels in 2017. There is a greater number of barge trips because towboats can pull more than one barge. Total waterborne transportation costs for towboats and barge trips are calculated for the without and with canal conditions as shown in the table below. Annual waterborne transportation cost savings for US flag cargo vessels transiting the canal are estimated at $1,698,700 as presented in Table D-19 below ($10,369,200 - $8,670,500). This reflects cost savings on US flag vessels only, which in 2017 included 90 percent of total cargo tonnage and 78 percent of cargo vessel trips.

Table D - 20: Steps to Estimate Impact to Navigation

Annual Waterborne Transportation Costs					
Without Canal Condition					
	# Vessel Trips, 2017	Distance (Nautical Miles)	Average Trip Length (Days)	Daily Operating Costs	Annual Costs
Towboats	230	378	2.1	$15,185	$7,334,300
Tanker Barges	833	378	2.1	$1,672	$2,924,000
Dry Cargo Barges	61	378	2.1	$866	$110,900
Total	1,124				$10,369,200
With Canal Condition					
	# vessel trips, 2017	distance (nautical miles)	average trip length (days)	Daily Operating Costs	Annual Costs
Towboats	230	316	1.76	$15,185	$6,132,800
Tanker Barges	833	316	1.76	$1,672	$2,445,000
Dry Cargo Barges	61	316	1.76	$866	$92,700
Total	1,124				$8,670,500
Annual Transportation Cost Savings, US Flag Cargo Vessels					**$1,698,700**

Without the Canal, the economic efficiencies of the shorter transit routes would be lost. The value of the bridges is that car traffic does not interrupt waterway traffic.

It should be noted that this simplified analysis did not consider factors including, some cargo traffic currently transiting by towboat and barge could be shipped by other means, such as over land by truck, in which case these benefits may be understated, or on larger self-propelled vessels, in which case these benefits may be overstated. There may be factors such as terminal capacity, terminal facilities, access channel depths, or berth depths that require or favor towboat and barge shipments. Since the $1,698,700 in transportation cost savings reflect only US flag vessel trips, this is used as the lower bound estimate of the navigation benefits provided by the canal. In 2017, there were roughly 3.6 times more domestic vessel trips than foreign flag vessel trips through the canal. There are also trips by many other types of vessels. The economic value derived from these other trips is estimated to be roughly 28% to the cost savings to US flag vessels, an additional $471,900, for a total estimate of $2,170,600 in 2020 dollars.

4.4.6 Navigation Impacts of Temporary Canal Closure

With a bridge collapse or other major failure, the Canal would likely be closed for some period of time. In addition, some of the repair/rehabilitation alternatives require temporary closure of the canal to stage equipment or for other reasons. In these cases, existing vessel traffic through the canal would be stopped temporarily, and the economic and safety benefits provided by the canal would be lost for that time period.

The impacts on navigation traffic of temporary canal closure for different time periods are summarized in Table D - 21 below.

Table D - 21: Navigation Impacts

Navigation Impacts, Cape Cod Canal			
	Annual Value	**Daily Value**	**Hourly Value**
2020 Value	$2,170,600	$5,900	$200

4.5 Annual Maintenance Costs

In addition to the costs associated with emergency repairs, there are annual maintenance costs to upkeep the bridges each year. Annual maintenance include activities such as maintenance painting, paving, and joint replacement.

Currently, average annual maintenance costs are $411,000 (in 2020 dollars) for the Sagamore Bridge and $295,000 for the Bourne Bridge. These numbers were assumed to remain constant for the without project condition. The annual maintenance costs were determined by the study's engineering expert by evaluating total maintenance of the current bridges over the last 50 years and finding an average annual cost.

In the event tree scenario in which there is catastrophic failure in the superstructure, the result is immediate closure of the bridge with the design and construction of a replacement bridge. Annual maintenance for replacement bridges will cost $38,000 each.

4.6 Results of Monte Carlo Simulation

The emergency repair costs (from Table D-1) and regularly scheduled O&M costs (see page D-44) as well as the value of time due to traffic and navigation costs were used as inputs for the Monte Carlo simulation as described in sections 1.1 and 2.3.1.Table D - 22 and Table D - 23 summarize the results.

Table D - 22: Sagamore Bridge Base Condition Costs

Annual Costs (rounded), ($000) FY2020					
	Repair Cost	**Navigation Cost**	**Travel Cost**	**O&M Cost**	**Total**
Base Condition	2,800	0.7	118,900	400	**122,100**

Table D - 23: Bourne Bridge Base Condition Costs

Annual Costs (rounded), ($000) FY2020					
	Repair Cost	**Navigation Cost**	**Travel Cost**	**O&M Cost**	**Total**
Base Condition	3,200	0.7	60,700	300	**64,200**

The Monte Carlo Simulation was run with 100,000 iterations. In the base condition, continual maintenance is performed on the existing structures and emergency funds are provided in the event of performance failure. As the bridges age over time their conditions will deteriorate and emergency funds will be needed more frequently.

The travel costs are substantially higher for the Sagamore Bridge when compared to the Bourne Bridge. This is due to the fact that a lane or bridge closure on the Sagamore would strain the infrastructure around the Bourne Bridge, particularly the Bourne Rotary causing significant time delay for travelers waiting in traffic.

As the bridges continue to deteriorate in the base condition, weight restrictions are likely to be enforced and increased over time. Large cargo will need to either be shipped via marine traffic or separated into multiple smaller load trucks when crossing the bridges. It is difficult to predict what the load restrictions will be in a given year, particularly in the later years of the study, as well as predict the actions of heavy load traffic. Therefore, weight restrictions are not incorporated into the model resulting in a conservative estimate of travel impacts in Alternative A. This assumption does not impact the final conclusion determined within the report.

4.7 Summary of Future Without Project Condition

The base case condition stipulates that the bridges be maintained but their aging condition will continue to deteriorate over the 50-year study. The bridges will become increasingly unreliable resulting in higher occurrences of expensive emergency repairs. Impacts to travelers will be associated with the repairs. The total annual cost of operating the Sagamore and Bourne Bridges over 50 years is an estimated $186.3 million ($122.1 + 64.2 million) of which $6 million ($2.8 + $3.2 million) are direct emergency repair costs for component failures.

5 ALTERNATIVE B – MAJOR REHABILITATION

An alternative to the base condition is a major rehabilitation of both the Sagamore and Bourne bridges. The rehabilitation would avoid some of the emergency repair costs of a potential failure because the rehabilitated bridges will have improved reliability functions, meaning that the probability of component failure will decrease.

The rehabilitation project would include the following projects:

- Truss Span Deck Replacement
- Stringer Replacement/Repair
- Floorbeam Replacement/Repair
- Suspender Cable Replacement
- Abutment Span T-Beam Rehabilitation
- Abutment Span Deck Rehabilitation
- Bearing Repairs
- Joint Replacement
- Steel Truss Repairs
- Paving (Overlay)
- Painting of Structural Steel

The recommended timeline for the major rehabilitation is 2025 through 2027 for the Sagamore Bridge and 2029 to 2031 for the Bourne Bridge. For more details on the major rehabilitation project see Appendix A – Engineering Reliability Analysis.

5.1 Benefits

The benefits are the direct and quantifiable gains under the with-project scenario. The major rehabilitation project will improve the reliability of bridge components and therefore decrease the probability of unsatisfactory performance. Benefits represent a reduction in emergency repair costs following a component failure and associated time value costs from lane closures related to these repairs. Modelling these phenomena provides a method to quantify the net benefits for current and future users.

5.1.1 Probability of Unsatisfactory Performance

The rehabilitation project would result in more reliable bridges with significantly smaller probabilities of component failures over the life of the bridges. Below are probability of unsatisfactory performance charts exemplifying improved reliability functions.

Figure D - 15: Sagamore Rehabilitation Probability of a Bridge Deck Failure

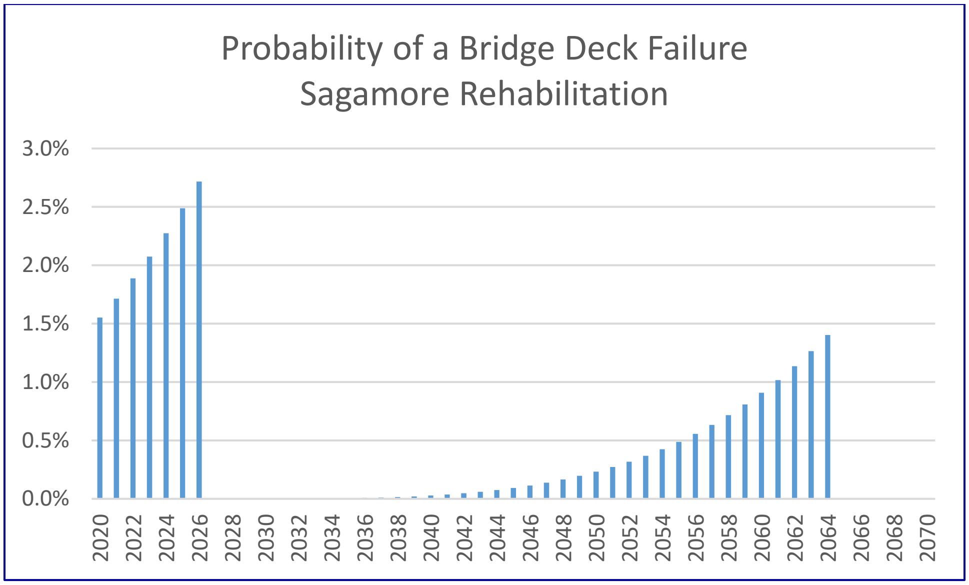
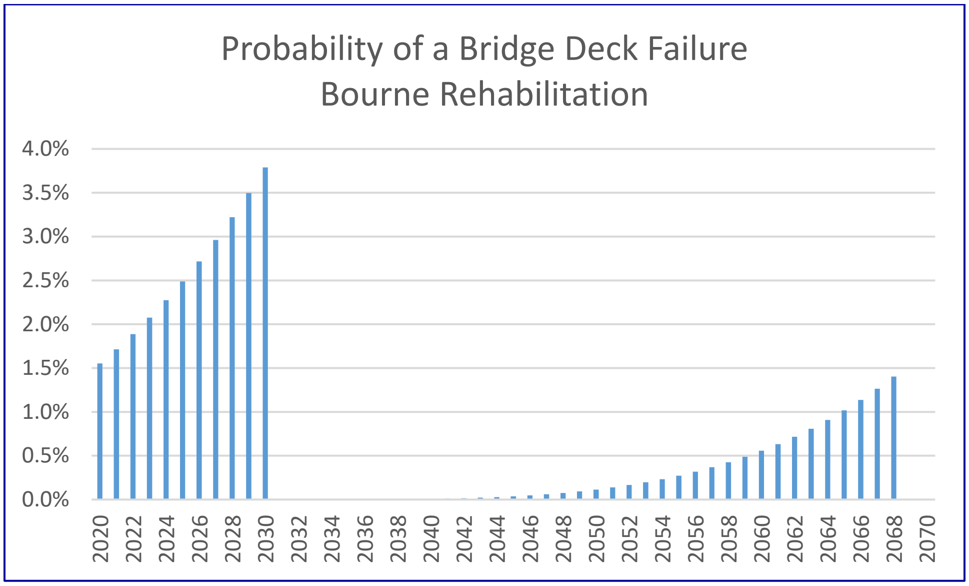


Figure D - 16: Bourne Rehabilitation Probability of a Bridge Deck Failure



As exhibited in Figure D - 15 and Figure D - 16, the probability of a failure for any type of bridge deck failure will be reset to 0% when the major rehabilitation project is complete. The probability of failure will rise throughout the forecast but will be reset to 0% when the second scheduled major repairs occurs. The probabilities of failure for both the Sagamore and Bourne Bridges remain below 1.5% following the major rehabilitation, compared to 37.4% at the end of the 50-years in the base condition.

Figure D - 17: Sagamore Rehabilitation Probability of a Substructure Failure

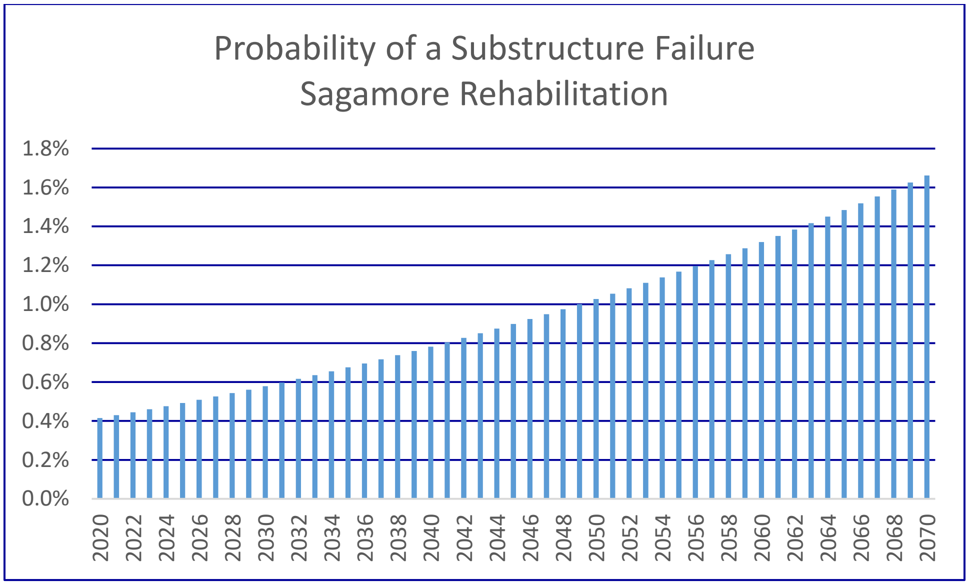
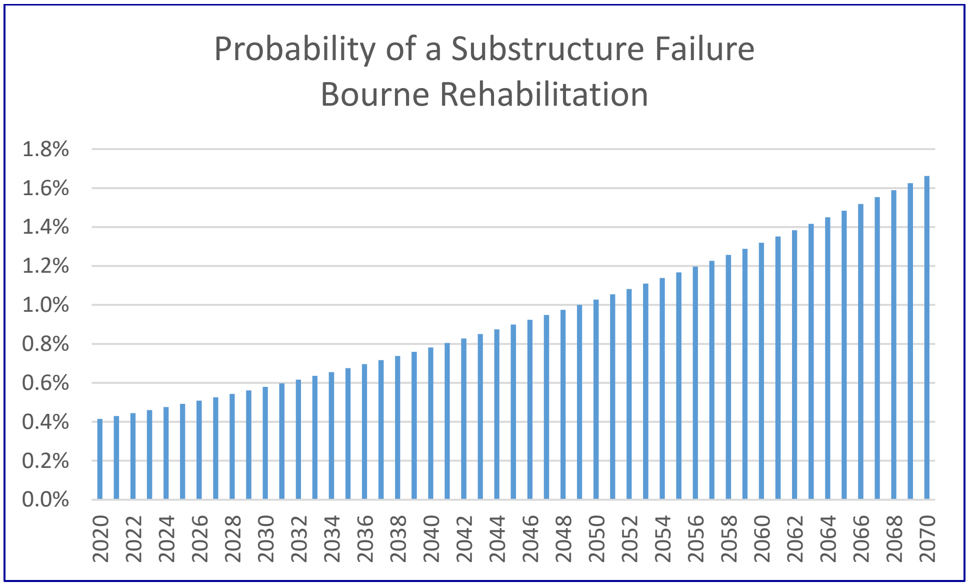


Figure D - 18: Bourne Rehabilitation Probability of a Substructure Failure



The major rehabilitation will not improve the substructure failure rate. It will continue to increase for both the Sagamore and Bourne Bridges over the 50-years similar to the base condition. According to expert engineering elicitation, even with the major rehabilitation project, the substructure component of the bridge will continue to show its age and will continue to deteriorate given its material composition.

Figure D - 19: Sagamore Rehabilitation Probability of a Superstructure Failure

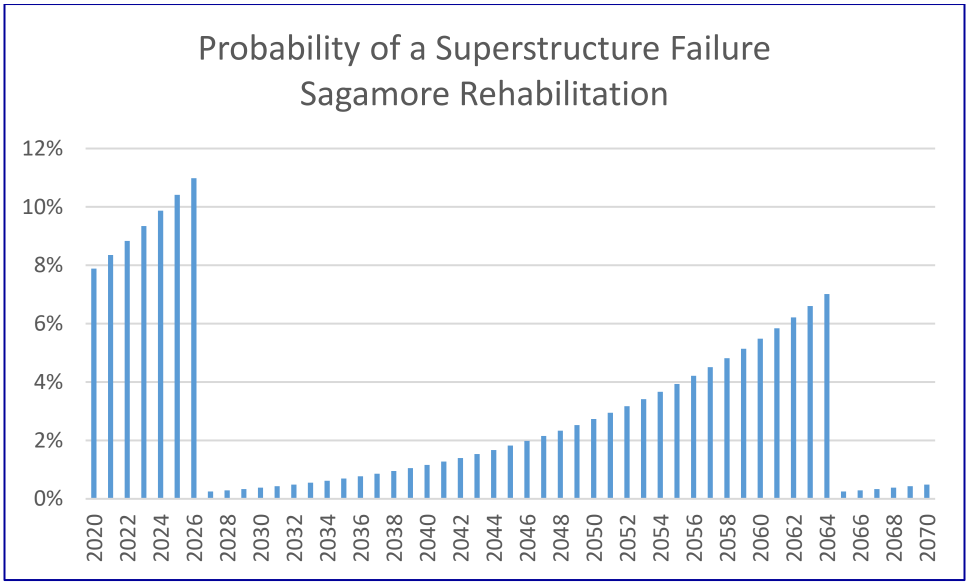
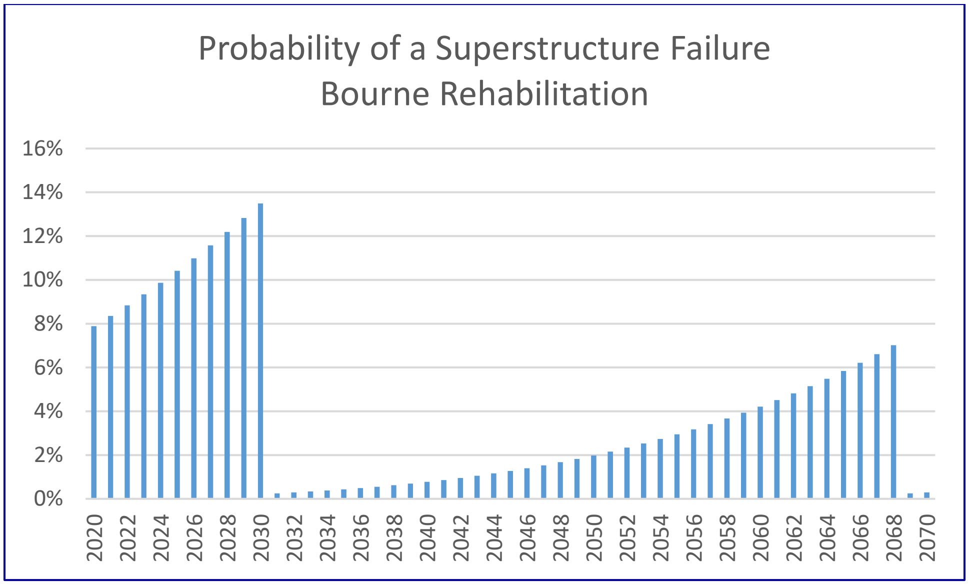


Figure D - 20: Bourne Rehabilitation Probability of a Superstructure Failure



As depicted in Figure D - 19 and Figure D - 20, the probability of a failure for any type of superstructure will be reduced to 0.3% following the rehabilitation to be in line with the failure rate in 1981, the historical last major rehab project. The probability of failure will rise throughout the forecast horizon before being adjusted back to 0.3% in the second scheduled major repair project. Failure rates will remain below 8% following the rehabilitation in both the Sagamore and Bourne Bridges, compared to 64.9% in the final year of the base condition.

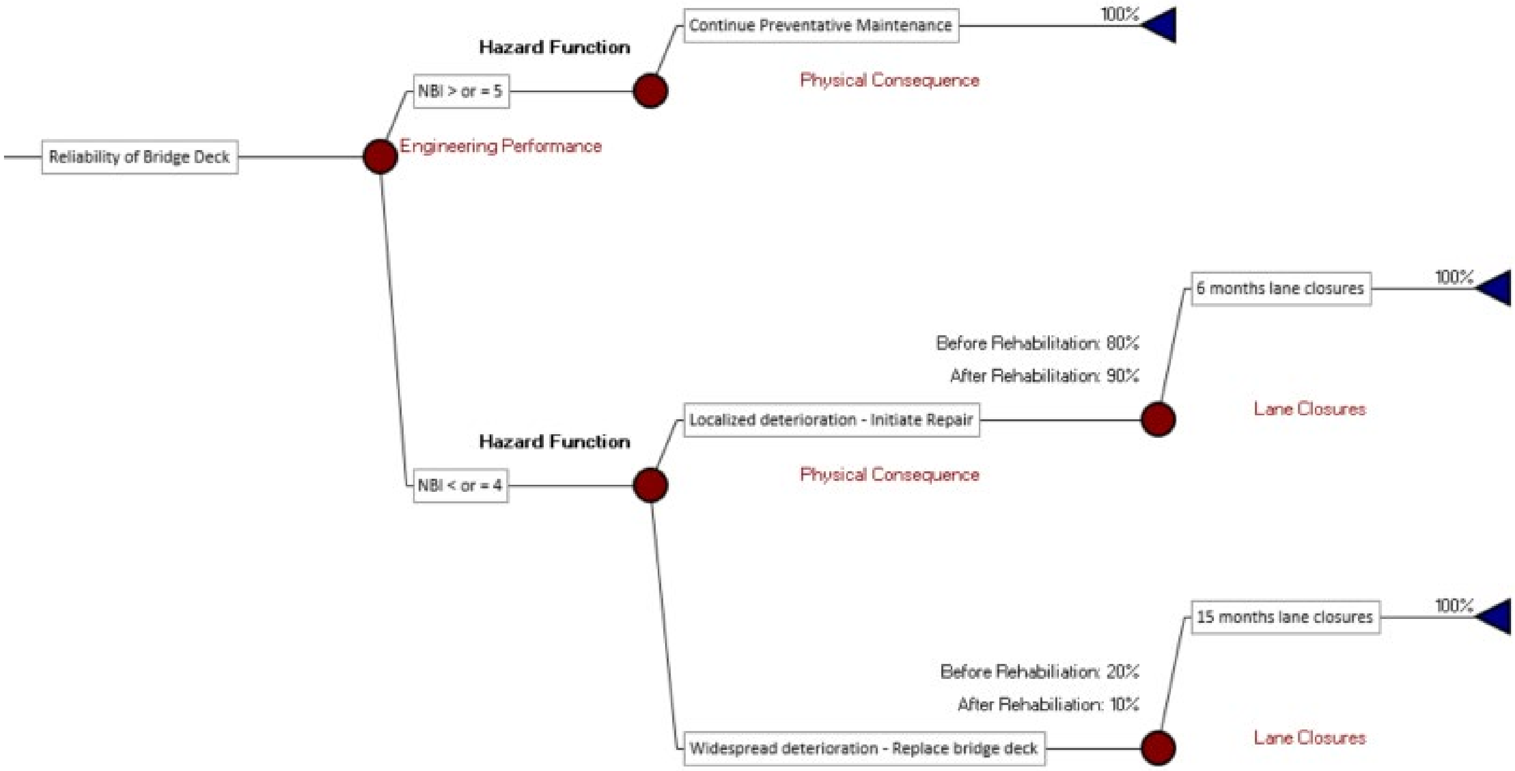
5.1.2 Probabilistic Scenario Analysis

Following the major rehabilitation, the event trees used to predict the severity of a component failure will be different than in the base condition. The major rehabilitation will hinder the occurrence of more severe component failures. Figures D-21, D-22 and D-23 below are the event trees for the three bridge components.

5.1.3 Results of Monte Carlo Simulation

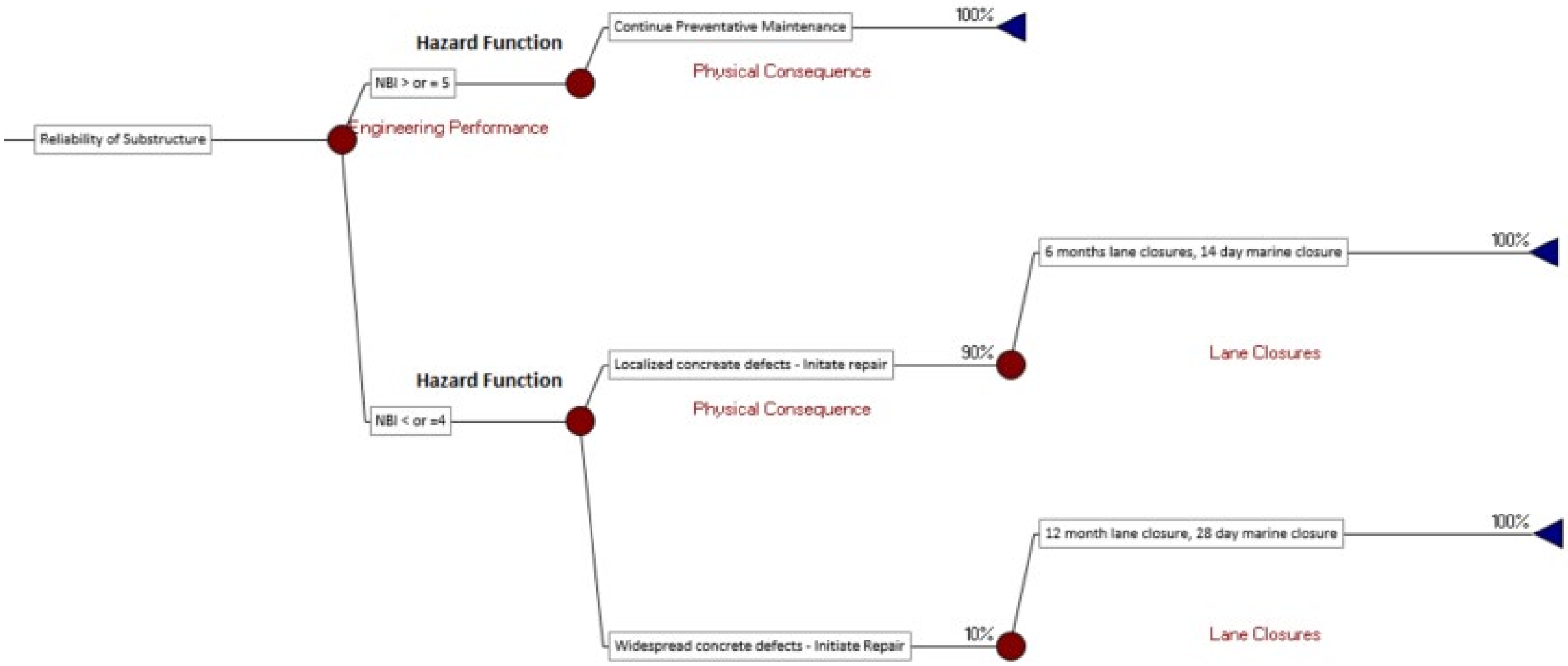
The repair, navigation, and travel costs are determined using Monte Carlo Simulation. After each failure, there is an associated emergency repair cost, possible navigation cost, and travel delay costs. These costs are consistent with the costs described in Section 3 of the base condition. This is because the bridges are structurally the same and initial costs for repairs will be the same before and after the major rehabilitation. The frequency in which failures occur, however, does decline. There will be fewer occurrences of component failures and the severity of the failures will also decrease after the rehabilitation projects. The O&M costs will remain the same in the rehabilitation scenario.

Figure D - 21: Rehabilitation Bridge Deck Event Tree



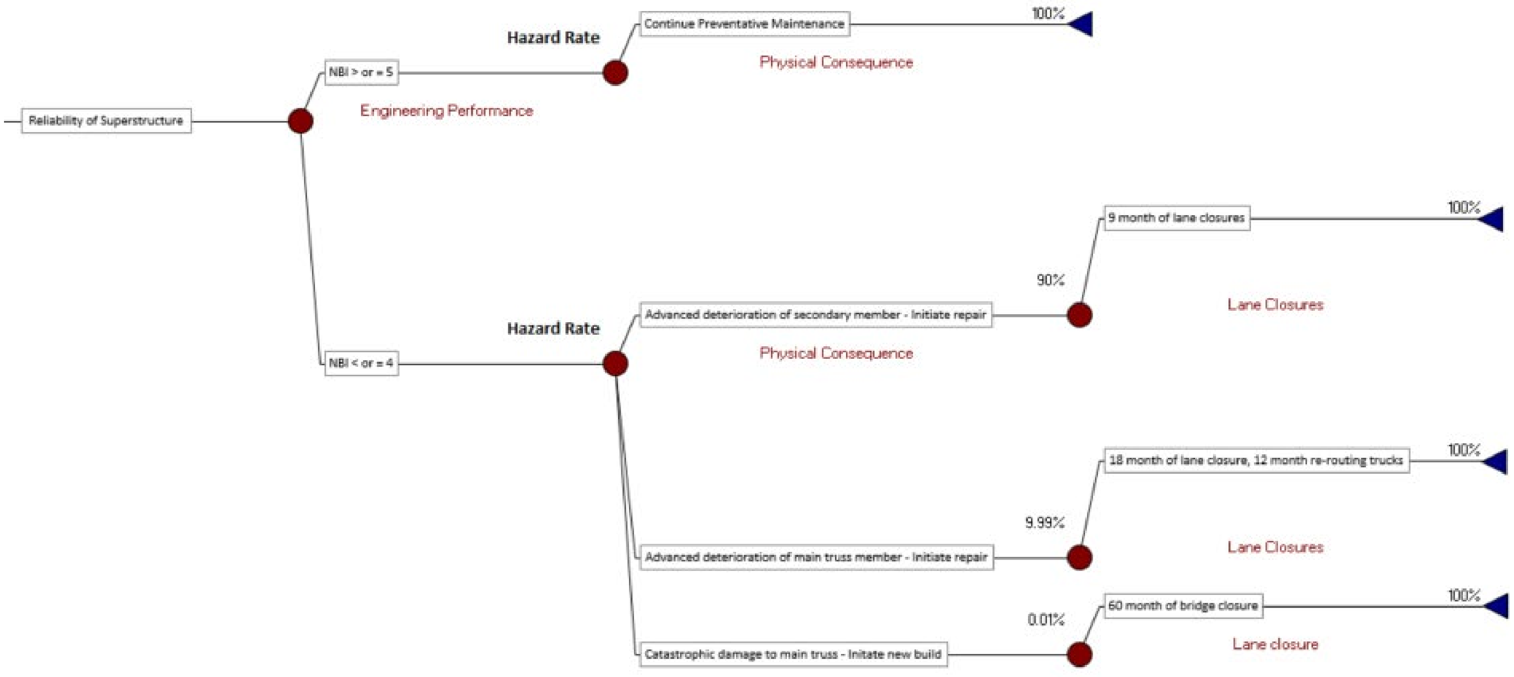
For both bridges after the major rehabilitation the probability that a bridge deck failure will lead to widespread deterioration compared to localized deterioration will decrease from 20% to 10% whereas in the base condition the probability of widespread deterioration increases over time as the component continues to worsen from 20% to 45%.

Figure D - 22: Rehabilitation Substructure Event Tree


Reliability of Substructure
Engineering Performance
Hazard Function
NBI > or = 5
Continue Preventative Maintenance
100%
Physical Consequence
Hazard Function
NBI < or =4
Localized concreate defects - Initate repair
90%
Physical Consequence
6 months lane closures, 14 day marine closure
100%
Lane Closures
Widespread concrete defects - Initiate Repair
10%
12 month lane closure, 28 day marine closure
100%
Lane Closures

The major rehabilitation will not lead to a change in the event tree probabilities in the substructure for both bridges. The probability of widespread concrete defects will remain 10%, as with the base condition.

Figure D - 23: Rehabilitation Superstructure Event Tree


Reliability of Superstructure
NBI > or = 5
Engineering Performance
Hazard Rate
Continue Preventative Maintenance
Physical Consequence
100%
NBI < or = 4
Hazard Rate
Advanced deterioration of secondary member - Initiate repair
Physical Consequence
90%
9 month of lane closures
100%
Lane Closures
Advanced deterioration of main truss member - Initiate repair
9.99%
18 month of lane closure, 12 month re-routing trucks
100%
Lane Closures
Catastrophic damage to main truss - Initate new build
0.01%
60 month of bridge closure
100%
Lane closure

The event tree for the superstructure will remain constant after the major rehabilitation rather than have the probability of a severe failure increase overtime as in the base condition. Therefore the major rehabilitation will help to prevent more severe failures from occurring particularly in later years.

The Monte Carlo Simulation was done over the 50-year period for the major rehabilitation scenario with 100,000 iterations. The resulting emergency repair costs for the major rehabilitation alternative are described in Table D-24 and Table D-25 below.

Table D - 24: Sagamore Bridge Rehabilitation Costs

Annual Costs (rounded), ($000)					
	Repair Cost	Navigation Cost	Travel Cost	O&M Costs	Total
Alternative B	300	0.6	8,000	400	**8,700**

Table D - 25: Bourne Bridge Rehabilitation Costs

Annual Costs (rounded), ($000)					
	Repair Cost	Navigation Cost	Travel Cost	O&M Costs	Total
Alternative B	400	0.6	5,400	300	**6,100**

To determine the benefit of the alternative, the cost savings of emergency repairs in the base case and the major rehab are compared by subtracting the costs of major rehab from the base case total costs. These calculations are shown in Tables D-26 and D-27.

Table D - 26: Sagamore Bridge Rehabilitation Benefits

Annual Costs, ($000)			
	Total Cost - Base Case	Total Cost - Major Rehab	Benefit
Alternative B	122,100	8,700	113,300

Table D - 27: Bourne Bridge Rehabilitation Benefits

Annual Costs, ($000)			
	Total Cost - Base Case	Total Cost - Major Rehab	Benefit
Alternative B	64,200	6,100	58,100

The costs for repairing the bridges after the major rehabilitation declines significantly as fewer failures are simulated over the 50-years. In addition, the travel delay costs incurred by lane and bridge closures during these emergency repairs is also reduced. The measurable benefit of doing the rehabilitation is the total cost savings of $113.3 million annually for the Sagamore Bridge and $58.1 million annually for the Bourne Bridge.

5.2 Cost

The cost of the major rehabilitation comprises the total construction cost of the major rehabilitation and the time-value cost of the lane and bridge closures associated with the major rehabilitation construction.

The recommended timeline for the major rehabilitation is 2025 through 2027 for the Sagamore Bridge and 2029 to 2031 for the Bourne Bridge.

5.2.1 Construction Costs

The majority of costs for the alternative will be incurred at the beginning of the construction timeline. The construction cost of the major rehabilitation for the Sagamore Bridge is $258.3 million (2020 dollars). The cost of the project for the Bourne Bridge is $269.7 million. These costs are based on estimates from Cost Engineering as of August 2019. More details on cost are provided in Appendix C.

Over the 50 years, the bridges will begin to deteriorate resulting in necessary action to prevent component failures. At the time of the failure, the bridges will need to undergo various major repair projects that are fairly extensive and not considered to be regular annual maintenance repairs. Table D - 28 and Table D - 29 summarize the costs for the major rehabilitation projects, costs for subsequent major repairs, and the years in which they occur.

Note: there are additional scheduled repairs referenced in Appendix C: Cost Engineering that include maintenance painting, joint replacement, and paving. Those out-year projects are considered part of annual operation and maintenance (O&M) for the purpose of the economic analysis.

Table D - 28: Sagamore Bridge Rehabilitation Engineering Costs

Sagamore Bridge Construction Cost		
Project	**Years**	**Cost (000) 2020 dollars**
Major Rehab	2025-2027	$ 153,300
Complete painting	2045	$ 22,900
Truss Deck Replacement, floor beam repair, complete painting	2065	$ 82,100

Table D - 29: Bourne Bridge Rehabilitation Engineering Costs

Bourne Bridge Construction Cost		
Project	**Years**	**Cost (000) 2020 dollars**
Major Rehab	2029-2031	$ 155,400
Complete painting	2049	$ 19,300
Truss Deck Replacement, floor beam repair, complete painting	2069	$ 95,000

5.2.2 Value of Time

Table D - 30 displays estimated closure timeframes necessary for each project.

Table D - 30: Rehabilitation Lane Closure Durations Estimates

MAJOR REHAB ACTIVITY	**BOURNE**	**SAGAMORE**
	LANE CLOSURE DURATION (DAYS)	
BRIDGE SUPERSTRUCTURE DECK REPLACEMENT (INCLUDING STRINGER REPLACEMENT); ABUTMENT SPAN REPLACEMENT; (CONCRETE T-BEAMS) MISC. STEEL REPAIRS, ETC.; EXTERIOR GUSSET PLATE RETROFITS; INTERIOR GUSSET PLATE REPAIRS; MISC. CONCRETE REPAIRS, ETC.	165	135
SUSPENDER CABLE REPLACEMENT	65	70
PAVING	30	25
PAINTING	220	150
TOTAL DAYS OF LANE CLOSURES	**480**	**380**
	FULL BRIDGE CLOSURE DURATION (DAYS)	
INTERIOR GUSSET PLATE REPLACEMENT	70	95
FLOORBEAM REPLACEMENT	110	35
TOTAL DAYS OF FULL BRIDGE CLOSURE	**180**	**130**
Total Days of Disrupted Traffic	**660**	**510**

Lane closures and bridge closures will not occur Memorial Day through Columbus Day to avoid impacting the busy tourist travel seasons as well as Patriots Day and Thanksgiving weekends. While construction will occur on most winter days, there will be some days in which inclement weather will prevent construction activity. For modeling purposes, an estimated roughly three-quarters of winter days will allow for construction activity while the remaining constitute no construction due to holidays or severe winter weather conditions.

The lane and bridge closures will negatively impact commuters and vacationers traveling on and off the bridge. The calculations were done as described in Section 3.3.3.

Table D - 31 and Table D - 32 display the construction activities included in the major rehabilitation during the 50-year study period and the associated travel costs for each activity. Cost of Construction is carried forward from Table D - 28 and Table D - 29 above. Travel costs incorporates the number of days for lane and bridge closures from Table D - 30 above and the calculated Value of Time; discounted for the year in which the costs are incurred.

Table D - 31: Sagamore Bridge Rehabilitation Construction and Travel Costs

Years	Cost of Construction ($000)	Travel Cost ($000)	Total Cost by Year Incurred
2025-2027	153,300	661,800	815,100
2045	22,900	124,000	146,900
2065	82,100	495,200	577,300
Total	258,300	1,281,000	1,539,300

* Costs are discounted in final analysis

Table D - 32: Bourne Bridge Rehabilitation Construction and Travel Costs

Years	Cost of Construction ($000)	Travel Cost ($000)	Total Cost by Year Incurred
2029-2031	155,400	530,100	685,500
2049	19,300	87,000	106,300
2069	95,100	331,200	426,300
Total	269,800	948,300	1,218,100

* Costs are discounted in final analysis

Traffic disruptions associated with construction activities may cause some visitors to choose an alternate travel destination away from Cape Cod. There would be a substitution effect as these vacationers may decide to travel to other areas such as Maine, New Hampshire or Rhode Island. This impact is expected to be minimal as scheduled construction activities during construction of the proposed alternatives will avoid peak visitor travel times in the summer and on holidays.

Travelers driving to the Cape for work or non-vacation reasons will still need to commute over the bridges because they provide the only access on and off Cape Cod.

The economic analysis does not reflect the possible substitution effect of visitor volume. The current analysis provides a more conservative estimate in the case of the alternatives. If visitor traffic were to decline as a result of project construction in the alternatives, traffic flows would actually improve for the non-visitors and in turn reduce the value of time cost of the project. Therefore, the final decision will not change with this assumption.

5.2.3 Total Annualized Cost

The total cost of the rehabilitation will be $35.6 million annually for the Sagamore Bridge and $25.8 million annually for the Bourne Bridge.

Table D - 33 and Table D - 34). The impact of traffic delays is a major component in adding costs, highlighting the importance of these structures in traffic flows. Traffic delays on the Sagamore Bridge amounted to 510 days of disrupted traffic at an additional economic cost of $1.3 billion. Traffic delays on the Bourne Bridge amounted to 660 days of disrupted traffic for an additional cost of $948 million.

Interest during construction (IDC) is the cost incurred as interest while the disbursement of payments is distributed over the course of the project construction, as costs do not hit in one year but rather is assumed over the duration of the construction period. The time period for the IDC calculation was 3 years.

Table D - 33: Sagamore Bridge Rehabilitation Total Annualized Costs

Cost ($000)	
Construction cost of rehabilitation – 2025 through 2027 (2020 dollars)	153,300
Construction cost of additional rehab work – 2045 through 2069 (2020 dollars)	105,000
Travel delay costs (2020 dollars)	1,281,000
Discount factor	2.875%
Capital Recovery Factor	0.0379
Discounted cost of rehabilitation	129,400
Discounted additional rehab work	34,200
Discounted travel delay cost	769,200
Interest During Construction (IDC)	4,400
Total Cost	937,300
Annualized Cost	35,600

Table D - 34: Bourne Bridge Rehabilitation Total Annualized Costs

Cost ($000)	
Construction cost of rehabilitation (2020 dollars)	155,400
Construction cost of additional rehab work (2020 dollars)	114,300
Travel delay costs (2020 dollars)	948,300
Discount factor	2.875%
Capital Recovery Factor	0.0379
Discounted cost of rehabilitation	117,100
Discounted additional rehab work	32,200
Discounted travel delay cost	525,500
Interest During Construction (IDC)	4,500
Total Cost	679,300
Annualized Cost	25,800

5.3 Major Rehabilitation – Analysis Results

The benefits refer to the quantifiable, incremental gains that will accrue to the society as a result of the project ("with-project" condition), as compared to the current situation ("base" condition). The total benefits from decreased emergency repairs following component failures in the base (existing) condition are compared to the total cost of the major rehabilitation which includes both construction costs and value of time costs from delays. A benefit-cost ratio (BCR) greater than one indicates that the project's benefits outweigh the costs. The study showed that both rehabilitation projects result in net benefits and benefit-cost-ratios greater than 1.

Table D - 35 and Table D - 36 summarize the total benefits, costs, net benefits, and benefit-cost ratios of the major rehabilitation project. The figures below are the @Risk output results exemplifying the BCR statistics of the Monte Carlo Simulation. In summary, the net benefit of the major rehabilitation project is $77.7 million annually for the Sagamore Bridge and $32.3 million for the Bourne Bridge. Both projects yield a benefit-cost-ratios (BCR) of over 1, with 3.2 and 2.3 respectively. Therefore there is economic justification for the major rehabilitation projects when compared to the base condition.

5.3.1 Results – Sagamore Bridge

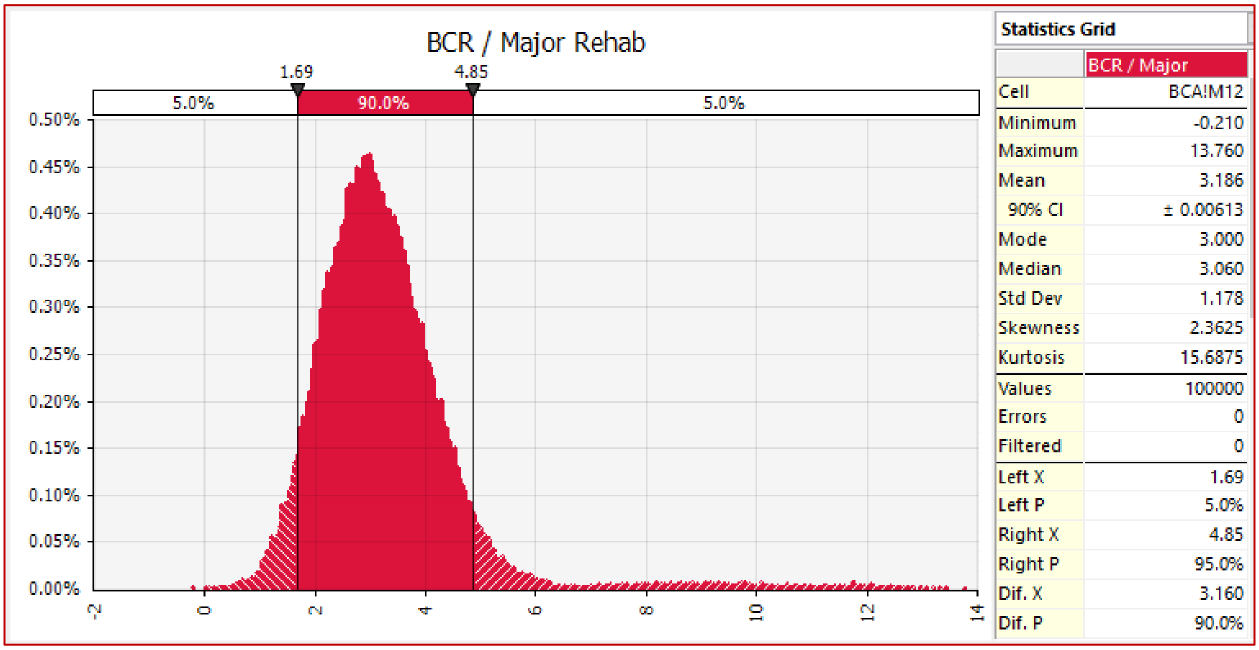
Average annual benefits for the Sagamore Bridge rehabilitation amounted to $113.3 million compared to average annual costs of $35.6 million yielding net benefits of $77.7 million. The BCR outcome of the Monte Carlo simulations has a mean of 3.2 and a standard deviation of 1.2 as shown in Figure D-24 – below. At the 90% confidence interval, the BCR will be between 1.7 and 4.9. The median expected outcome of all simulations was a BCR of 3.1.

Figure D - 25 similarly shows the @RISK results for the net benefits. At the 90% confidence interval, the net benefits will be between $24.7 million and $136.9 million with the median value of $73.4 million.

Table D - 35: Sagamore Bridge Rehabilitation Costs and BCR

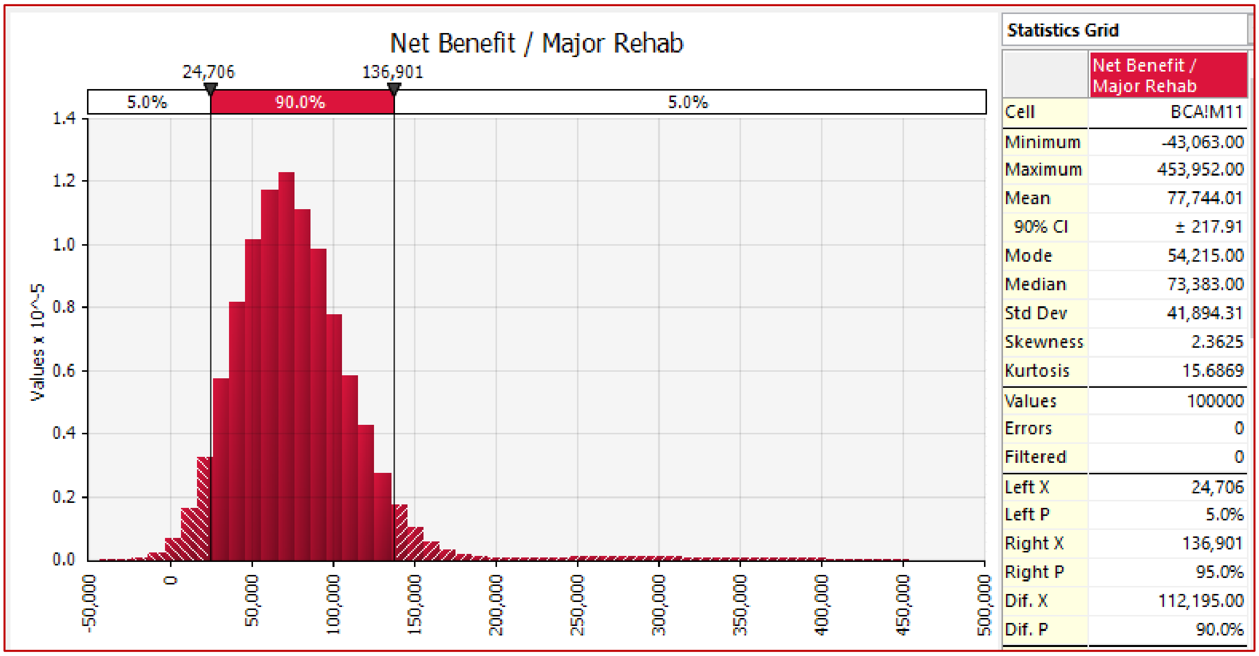
Annual ($000)				
	Benefit	**Cost**	**Net Benefit**	**BCR**
Alternative B	113,300	35,600	77,700	3.2

Figure D - 24: Sagamore Major Rehabilitation @RISK Output BCR



	BCR / Major
Cell	BCA!M12
Minimum	-0.210
Maximum	13.760
Mean	3.186
90% CI	± 0.00613
Mode	3.000
Median	3.060
Std Dev	1.178
Skewness	2.3625
Kurtosis	15.6875
Values	100000
Errors	0
Filtered	0
Left X	1.69
Left P	5.0%
Right X	4.85
Right P	95.0%
Dif. X	3.160
Dif. P	90.0%

Figure D - 25: Sagamore Major Rehabilitation @RISK Output Net Benefit



	Net Benefit / Major Rehab
Cell	BCA!M11
Minimum	-43,063.00
Maximum	453,952.00
Mean	77,744.01
90% CI	± 217.91
Mode	54,215.00
Median	73,383.00
Std Dev	41,894.31
Skewness	2.3625
Kurtosis	15.6869
Values	100000
Errors	0
Filtered	0
Left X	24,706
Left P	5.0%
Right X	136,901
Right P	95.0%
Dif. X	112,195.00
Dif. P	90.0%

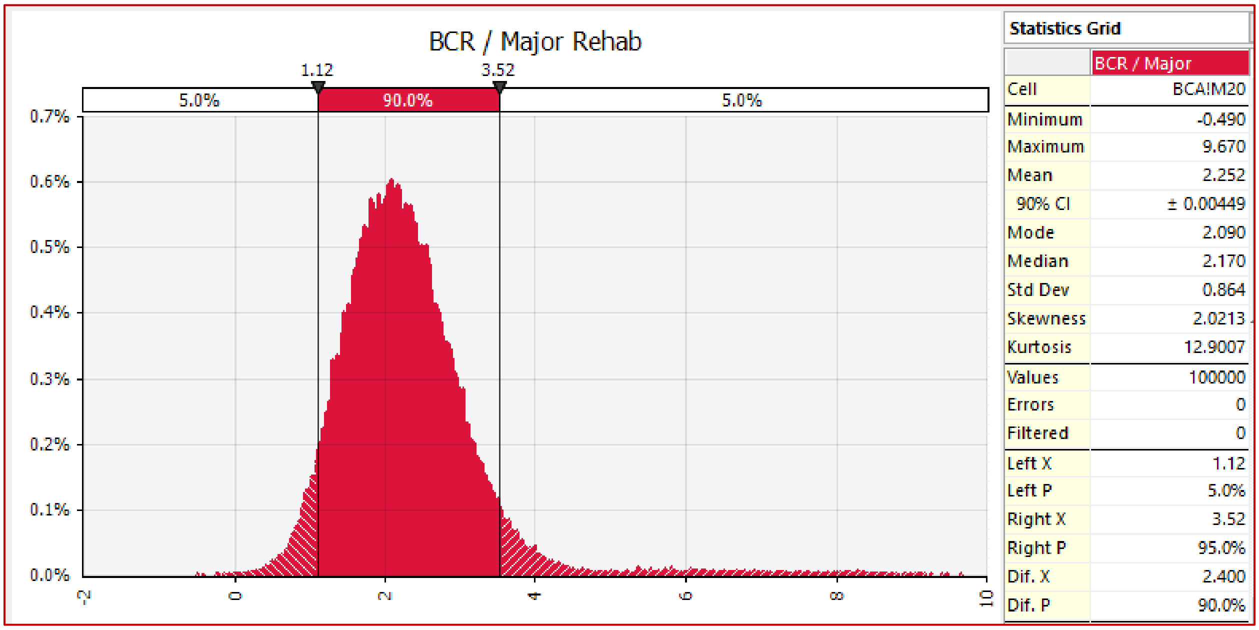
Average annual benefits for the Bourne Bridge rehabilitation amounted to $58.1 million compared to average annual costs of $25.8 million yielding net benefits of $32.3 million. The BCR outcome of the Monte Carlo simulations has a mean of 2.3 and a standard deviation of 0.9 as shown in Figure D - 26 below. At the 90% confidence interval, the BCR will be between 1.1 and 3.5. The median expected outcome of all simulations was a BCR of 2.2.

Figure D - 25 exhibits the @RISK results for the net benefits. At the 90% confidence interval, the net benefits will be between $3.2 million and $65 million with the median value of $30.1 million.

Table D - 36: Bourne Bridge Rehabilitation Costs and BCR

Annual Cost ($000)				
	Benefit	**Cost**	**Net Benefit**	**BCR**
Alternative B	58,100	25,800	32,300	2.3

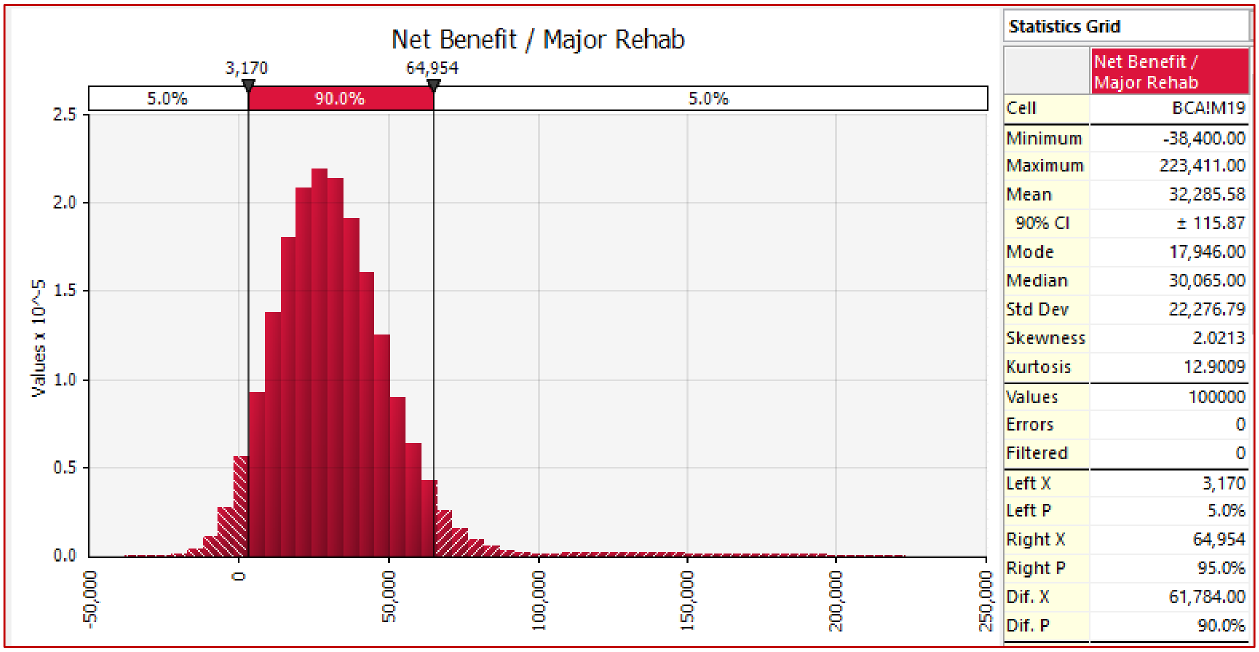
Figure D - 26: Bourne Major Rehabilitation @RISK Output BCR



Statistics Grid

	BCR / Major
Cell	BCA!M20
Minimum	-0.490
Maximum	9.670
Mean	2.252
90% CI	± 0.00449
Mode	2.090
Median	2.170
Std Dev	0.864
Skewness	2.0213
Kurtosis	12.9007
Values	100000
Errors	0
Filtered	0
Left X	1.12
Left P	5.0%
Right X	3.52
Right P	95.0%
Dif. X	2.400
Dif. P	90.0%

Figure D - 27: Bourne Major Rehabilitation @RISK Output Net Benefits



Statistics Grid

	Net Benefit / Major Rehab
Cell	BCA!M19
Minimum	-38,400.00
Maximum	223,411.00
Mean	32,285.58
90% CI	± 115.87
Mode	17,946.00
Median	30,065.00
Std Dev	22,276.79
Skewness	2.0213
Kurtosis	12.9009
Values	100000
Errors	0
Filtered	0
Left X	3,170
Left P	5.0%
Right X	64,954
Right P	95.0%
Dif. X	61,784.00
Dif. P	90.0%

5.4 Summary of Major Rehabilitation Project

The analysis supports the major rehabilitation projects for both bridges over maintaining the bridges in the "fix-as-fails" Base Condition. The study showed that both rehabilitation projects result in net benefits and benefit-cost-ratios greater than 1. The impact of traffic delays is a major component in adding costs highlighting the importance of these structures in traffic flows.

6 ALTERNATIVE C – REPLACEMENT WITH 4 LANES (2 EACH DIRECTION)

A proposed alternative to the base condition and the major rehabilitation is the construction of new bridges adjacent to the current bridges. This scenario has a greater upfront cost but also allows for a more reliable bridge structure that meets current standards and regulations. The first proposed bridge is a directly comparable replacement with 4 lanes total (2 each direction), but would be wider to meet current standards. The new bridges do not require lane and bridge closures during the construction process and will therefore not impact traffic or incur travel delays during construction. This alternative also has lower annual maintenance costs after the replacement bridges are erected. However construction costs are higher than the costs of rehabilitation.

The recommended timeline for the construction of the new bridges is 2025 through 2029 for the Sagamore Bridge and 2030 to 2034 for the Bourne Bridge.

6.1 Benefits

The benefits are the direct and quantifiable gains under the with-project scenario. Replacement of the bridges will improve the reliability of bridge components and therefore significantly decrease the probability of failure. In this situation, failure is defined as unsatisfactory conditions that would require limiting the weight (load-posting) allowed to be carried over the bridges. Benefits represent a reduction in emergency repair costs following a component failure and associated time value costs from lane closures related to these repairs. In addition, the new bridges will also have lower annual maintenance costs throughout the 50-year forecast. Modelling these phenomena provides a method to quantify the net benefits for current and future users.

6.1.1 Probability of Unsatisfactory Performance

The replacement bridge project will result in more reliable bridges with significantly smaller probabilities of component failures over the life of the bridges. Below are probability of unsatisfactory performance charts exemplifying improved reliability functions.

Figure D - 28: Sagamore Replacement Probability of a Bridge Deck Failure

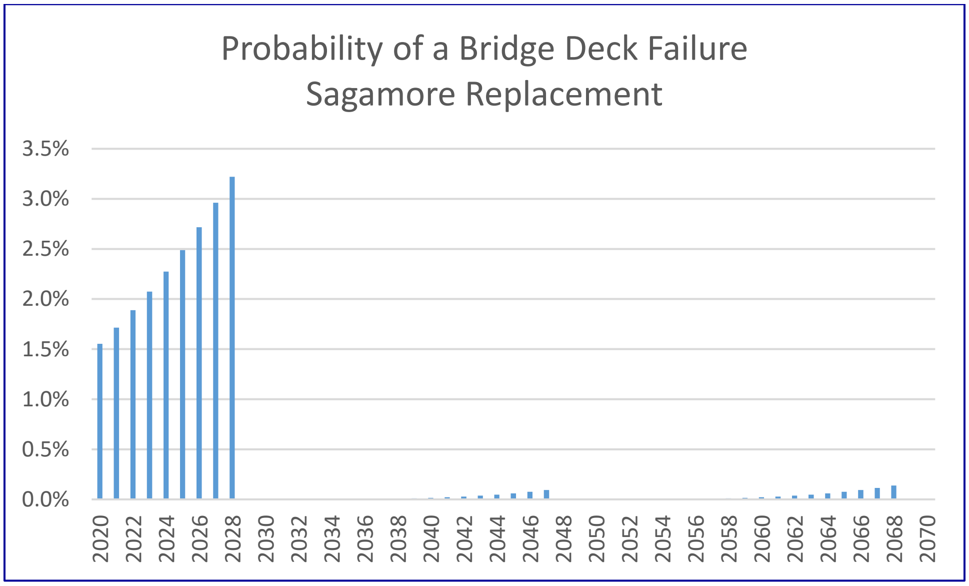


Figure D - 29: Bourne Replacement Probability of a Bridge Deck Failure

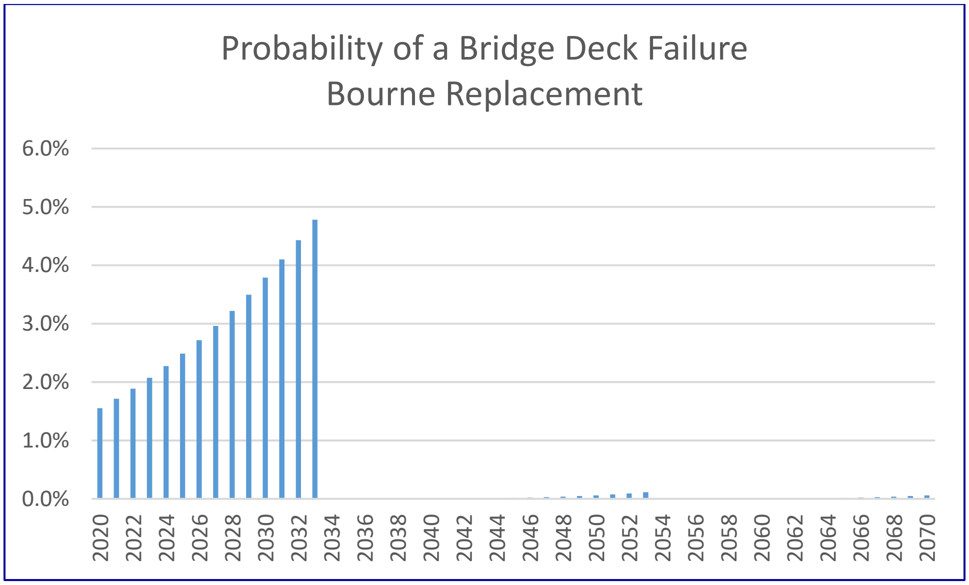


Figure D - 28 and Figure D-29 display the probability of a bridge deck failure which will be reset to 0% when the replacement project is complete. The probability of failure will slowly rise throughout the forecast horizon and will reset to 0% again during scheduled major repairs. The probability of failure will be near nil for the remainder of the forecast (below 0.2%) following the replacement project. By comparison, the base condition reached 37.4% in the final year of the evaluation.

Figure D - 30: Sagamore Replacement Probability of a Substructure Failure

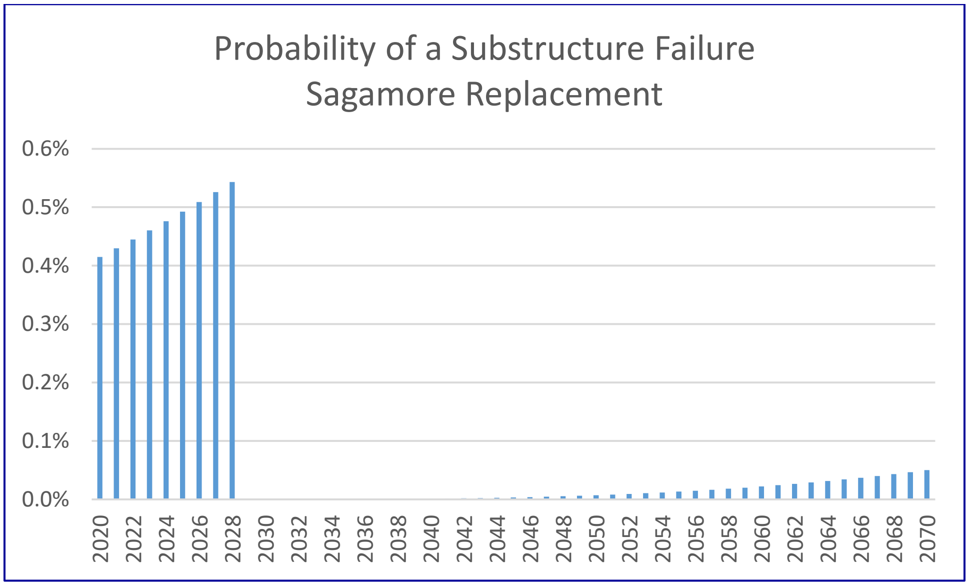
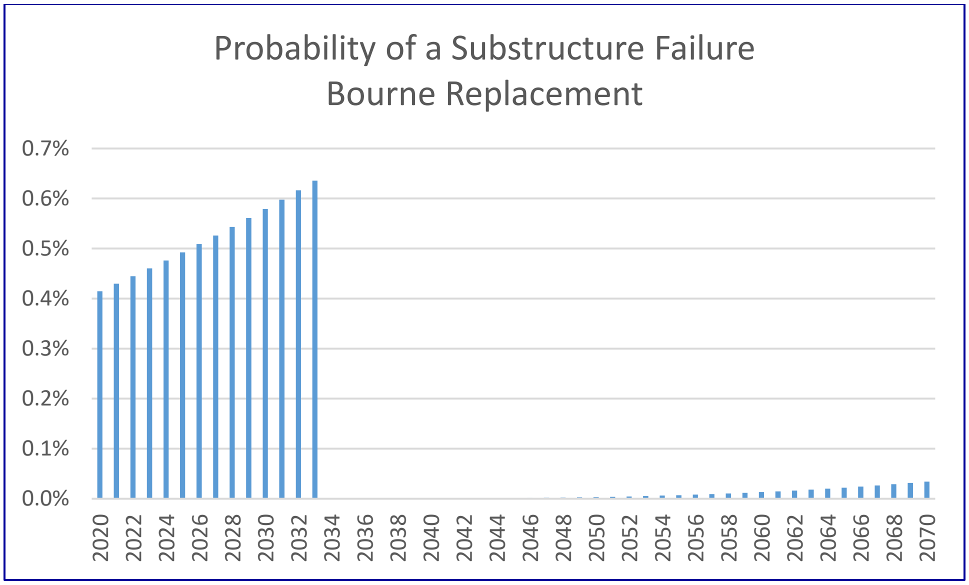


Figure D - 31: Bourne Replacement Probability of a Substructure Failure



The probability of a substructure failure will be reset to 0% when the replacement bridge project is complete. The probability of failure will slowly rise throughout the forecast horizon, reaching 0.05% in 2069 for the Sagamore Bridge and 0.03% for the Bourne Bridge compared to 1.7% in the base condition.

Figure D - 32: Sagamore Replacement Probability of a Superstructure Failure

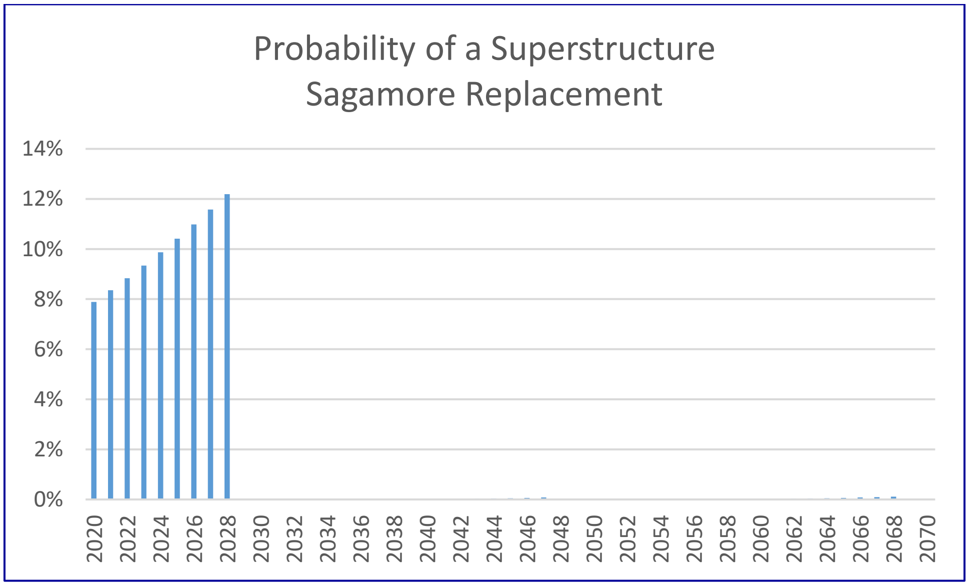


Figure D - 33: Bourne Replacement Probability of a Superstructure Failure

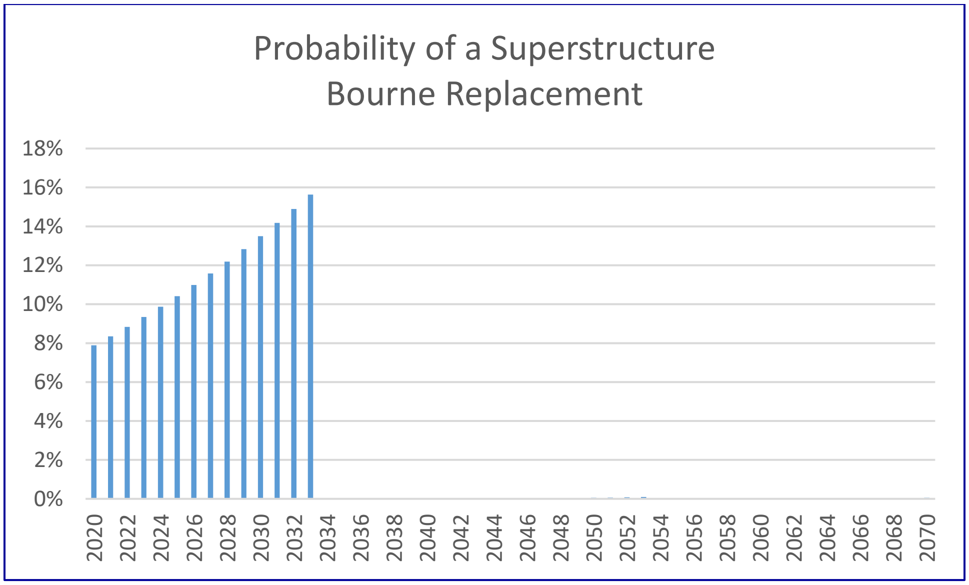
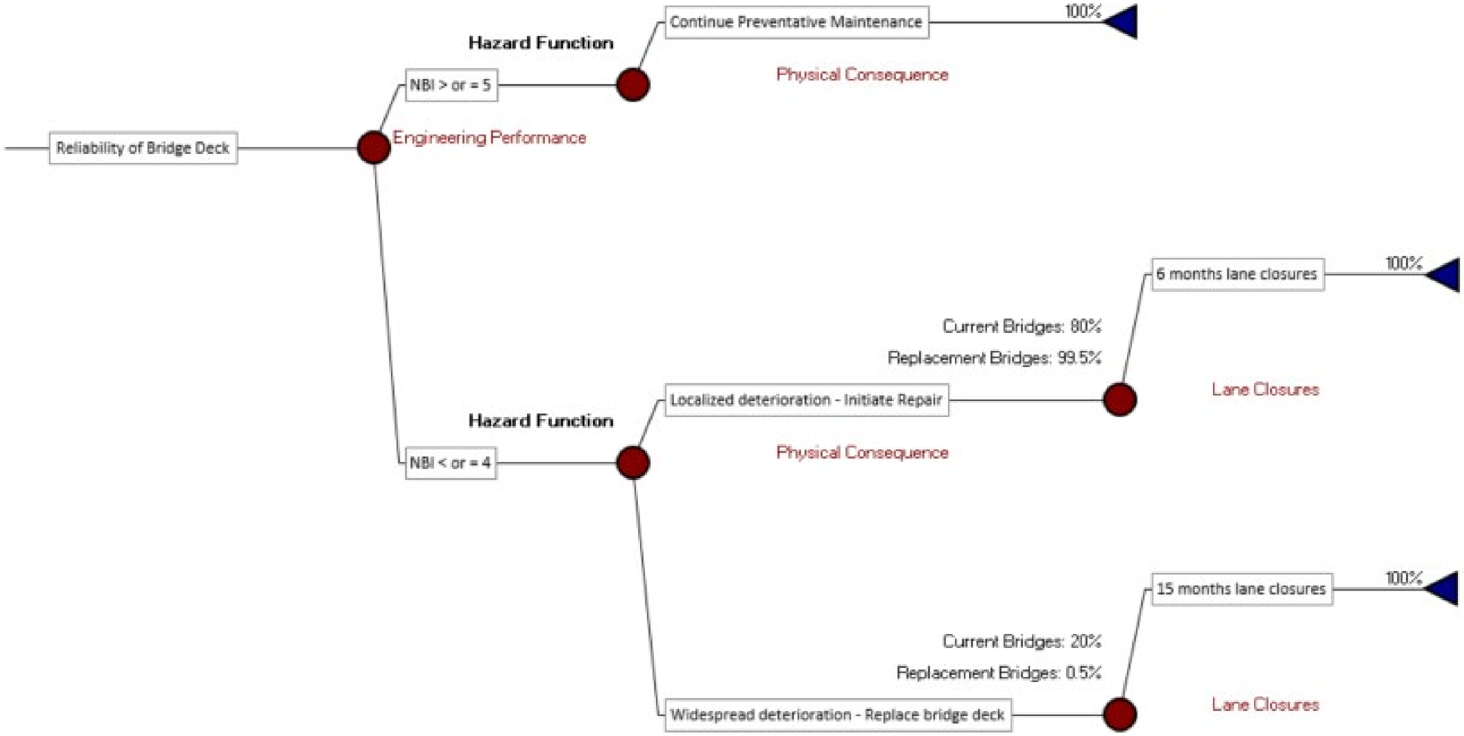


Figure D - 32 and Figure D - 33 exhibit the probability of a superstructure failure which will be reset to 0 when the bridge replacement project is complete. The probability of failure will slowly rise throughout the forecast horizon and will again be reset after the scheduled second major repair. The probability of failure in the superstructure will remain below 0.1% in the years following the replacement. By comparison, the base condition probability of failure raises to 64.9% by 2069.

6.1.2 Probabilistic Scenario Analysis

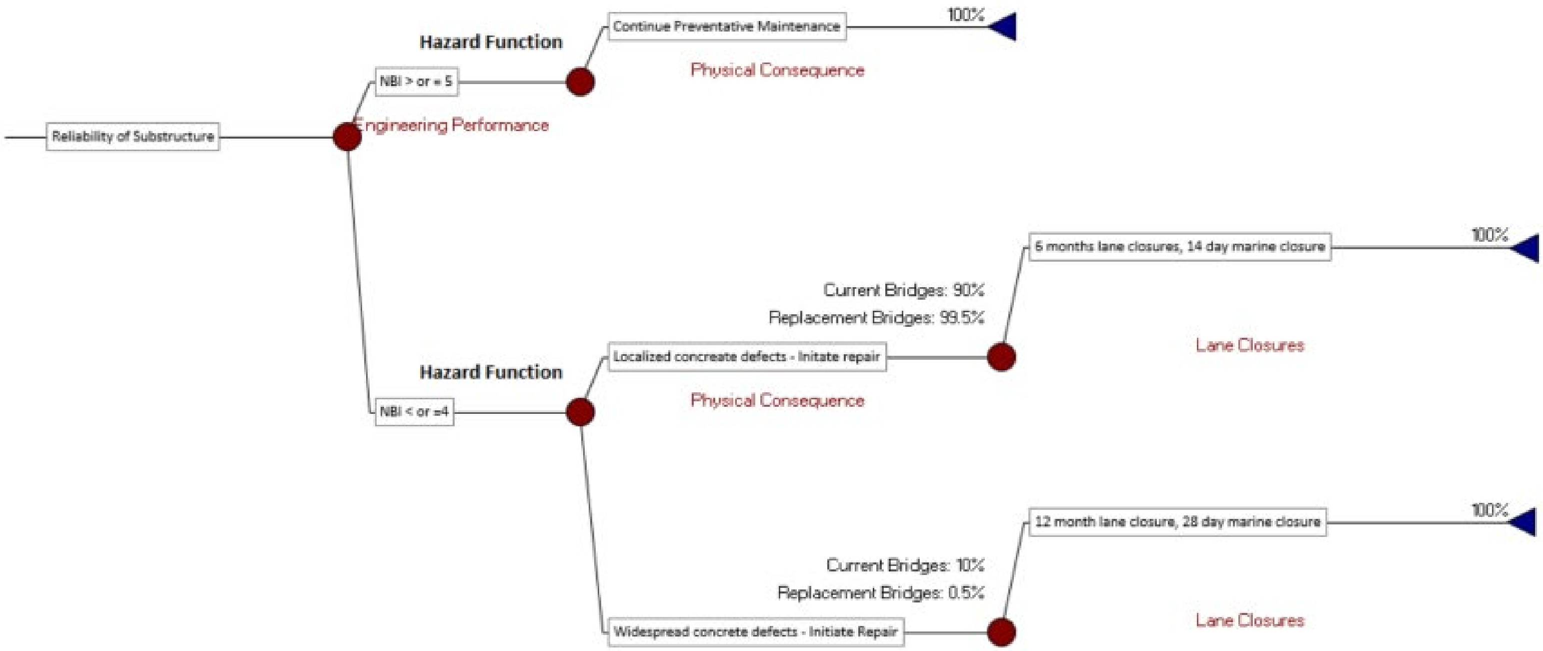
Following the replacement project, the event trees used to predict the severity of a component failure will be different for the new bridges constructed. The replacement project will hinder the occurrence of more severe component failures. Below are the event trees for the three bridge components for the new bridges.

Figure D - 34: Replacement Bridge Deck Event Tree



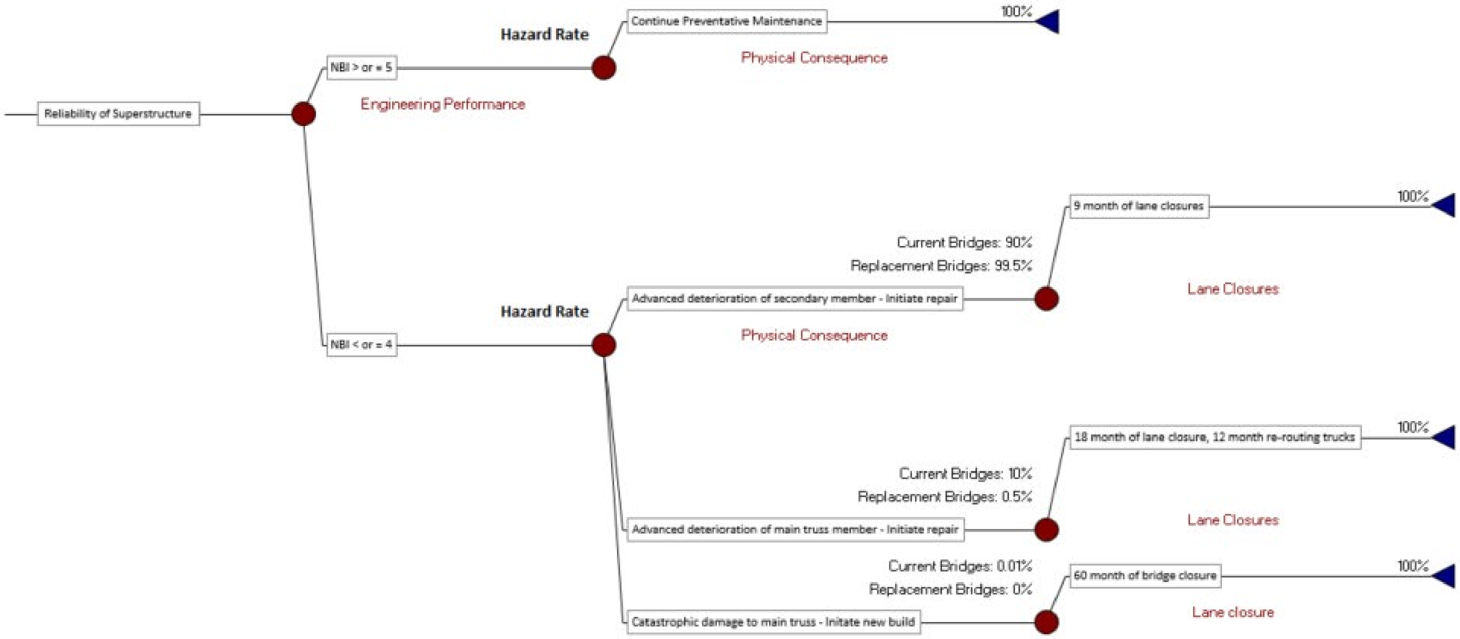
For both replacement bridges, the probability that a bridge deck failure will lead to widespread deterioration will be 0.5% whereas in the base condition the probability of widespread deterioration increases over time as the component continues to worsen, increasing from 20% to 45%.

Figure D - 35: Replacement Substructure Event Tree


Reliability of Substructure
Engineering Performance
Hazard Function
NBI > or = 5
Continue Preventative Maintenance
Physical Consequence
100%
Hazard Function
NBI < or =4
Physical Consequence
Current Bridges: 90%
Replacement Bridges: 99.5%
Localized concreate defects - Initate repair
6 months lane closures, 14 day marine closure
100%
Lane Closures
Current Bridges: 10%
Replacement Bridges: 0.5%
Widespread concrete defects - Initiate Repair
12 month lane closure, 28 day marine closure
100%
Lane Closures

Unlike the major rehabilitation, the replacement project would improve the condition of the substructure and decrease the probability of widespread concrete deficits compared to localized concrete deficits. The replacement bridges will have a 0.5% probability of widespread concrete deficits compared to the base and rehabilitation conditions which have a 10% probability of widespread deficits.

Figure D - 36: Replacement Superstructure Event Tree



Reliability of Superstructure
NBI > or = 5
Engineering Performance
Hazard Rate
Continue Preventative Maintenance
Physical Consequence
100%
NBI < or = 4
Hazard Rate
Current Bridges: 90%
Replacement Bridges: 99.5%
Advanced deterioration of secondary member - Initiate repair
Physical Consequence
9 month of lane closures
100%
Lane Closures
Current Bridges: 10%
Replacement Bridges: 0.5%
Advanced deterioration of main truss member - Initiate repair
18 month of lane closure, 12 month re-routing trucks
100%
Lane Closures
Current Bridges: 0.01%
Replacement Bridges: 0%
Catastrophic damage to main truss - Initate new build
60 month of bridge closure
100%
Lane closure

The event tree for the superstructure improves in the replacement bridge scenario rather than remaining constant in the rehabilitation or worsening over time as in the base condition. There will be a 0% chance that the new bridge will have catastrophic damage to the superstructure over the 50-year study period. 99.5% of failures of the superstructure will be minor.

6.1.3 Results of Monte Carlo Simulation

The repair, navigation, and travel costs are determined as described in the same process as the existing condition using Monte Carlo Simulation. The results for the replacement bridges are presented in Table D - 37 and Table D - 38.

Table D - 37: Sagamore Bridge Replacement 4 Lanes Costs

Annual Costs (Rounded) ($000)					
	Repair Cost	Navigation Cost	Travel Cost	O&M	Total
Alternative C	300	0.1	4,000	200	**4,400**

Table D - 38: Bourne Bridge Replacement 4 Lanes Costs

Annual Costs (Rounded) ($000)					
	Repair Cost	Navigation Cost	Travel Cost	O&M	Total
Alternative C	500	0.2	6,300	200	**7,000**

To determine the benefit of the alternative, the cost savings of emergency repairs in the base case and the new bridge alternative are compared by subtracting the costs of the new bridge scenario from the base case total costs. The benefits are detailed in Table D - 39 and Table D - 40.

Table D - 39: Sagamore Bridge Replacement 4 Lanes Benefits

Annual Costs ($000)			
	Total Cost Base Case	Total Cost New Bridge (4)	Benefit
Alternative C	122,100	4,400	117,600

Table D - 40: Bourne Bridge Replacement 4 Lanes Benefits

Annual Costs, ($000)			
	Total Cost Base Case	Total Cost New Bridge (4)	Benefit
Alternative C	64,200	7,000	57,200

The occurrence of a component failure declines significantly over the study period after the replacement bridges are constructed. Therefore travel delay costs typically associated with these failures similarly are reduced. In addition, annual O&M costs to upkeep the new bridges are reduced. The measurable benefit of replacing the bridges is the total cost savings of $117.6 million annually for the Sagamore Bridge and $57.2 million annually for the Bourne Bridge.

6.2 Cost of Alternative

The costs of the new bridge construction is comprised of the total construction cost of the bridges. There will be limited impact to traffic as the new bridges will be constructed adjacent to the existing bridges. There will be some disruption to vessel traffic during the initial construction and travel delays will be incurred during regular maintenance repairs over the life of the new bridge.

6.2.1 Engineering Costs

The majority of costs for this alternative will be incurred at the beginning of the construction timeline. The total cost of the construction for the new Sagamore Bridge is $426.7 million (2020 dollars). The total cost of the project for the Bourne Bridge is $625.3 million.

A major rehabilitation or new bridge will not be necessary after 50 years, though scheduled repairs will be required.

Table D - 41: Sagamore Bridge Replacement 4 Lanes Engineering Costs

Sagamore Bridge		
Project	**Years**	**Cost (000) 2020 dollars**
New Bridge	2025-2029	$ 413,300
Major Repairs	2049	$ 6,700
Major Repairs	2069	$ 6,700

Table D - 42: Bourne Bridge Replacement 4 Lanes Engineering Costs

Bourne Bridge		
Project	**Years**	**Cost (000) 2020 dollars**
New Bridge	2030-2034	$ 618,600
Major Repairs	2054	$ 6,700

6.2.2 Value of Time

There are no expected lane or bridge closures during the construction of the new bridges as they will be constructed adjacent to the existing bridges. The existing bridges will continue to operate until the construction is completed and then traffic will be redirected with minimal impact on traffic delays.

However, during the scheduled repairs that are expected to occur later in the 50-year timeframe, there will be impacts to traffic. Table D - 43 and Table D - 44 show the construction costs and associated travel costs.

Table D - 43: Sagamore Bridge Replacement 4 Lanes Costs

Years	Cost of Construction ($000)	Navigation Cost ($000)	Travel Cost ($000)	Total Cost by Year Incurred
2025-2029	413,300	200	0	413,500
2049	6,700	0	46,300	53,000
2069	6,700	0	46,300	53,000
Total	426,700	200	92,600	519,500

* Costs are discounted in final analysis

Table D - 44: Bourne Bridge Replacement 4 Lanes Costs

Years	Cost of Construction ($000)	Navigation Cost ($000)	Travel Cost ($000)	Total Cost by Year Incurred
2030-2034	618,600	200	0	618,800
2054	6,700	0	22,200	28,900
Total	625,300	200	22,200	647,700

* Costs are discounted in final analysis

6.2.3 Total Annualized Cost

The total costs are annualized to determine the annual cost over the 50 year study. Table D - 45 and Table D - 46 exhibit the model Monte Carlo results and economic factors used to annualize costs. The construction time duration used for the interest during construction (IDC) is five years.

Table D - 45: Sagamore Bridge Replacement 4 Lanes Total Annualized Cost

Cost ($000)	
Construction cost of replacement (2020 dollars)	413,300
Construction cost of additional repair work (2020 dollars)	13,500
Travel and navigation delay costs (2020 dollars)	92,600
Discount factor	2.875%
Capital Recovery Factor	0.0379
Discounted cost of replacement cost	339,200

Discounted additional repair work	4,600
Discounted travel and navigation delay cost	31,900
Interest During Construction (IDC)	24,500
Total Cost	400,200
Annualized Cost	15,200

Table D - 46: Bourne Bridge Replacement 4 Lanes Total Annualized Cost

Cost ($000)	
Construction cost of replacement (2020 dollars)	618,600
Construction cost of additional repair work (2020 dollars)	6,700
Travel delay and navigation costs (2020 dollars)	22,200
Discount factor	2.875%
Capital Recovery Factor	0.0379
Discounted cost of replacement	440,600
Discounted additional repair work	2,600
Discounted travel delay and navigation cost	8,500
Interest During Construction (IDC)	36,600
Total Cost	488,300
Annualized Cost	18,500

6.3 Four Lane Replacement Bridge – Analysis Results

The total benefits from decreased emergency repairs following component failures on the existing bridge is compared to the total cost of the new bridge construction which includes engineering costs and scheduled repairs.

6.3.1 Benefit Cost Ratio (BCR)

Table D - 47 and Table D - 48 summarize the total benefits, costs, net benefits, and benefit-cost ratios of the replacement project. Figure D-37 and Figure D-38 are the @Risk output results exemplifying the BCR statistics of the Monte Carlo Simulation.

Average annual benefits for the Sagamore Bridge replacement amounted to $117.6 million compared to average annual costs of $15.2 million yielding net benefits of $102.4 million. The BCR outcome of the Monte Carlo simulations has a mean of 7.7 and a standard deviation of 2.7 as shown in

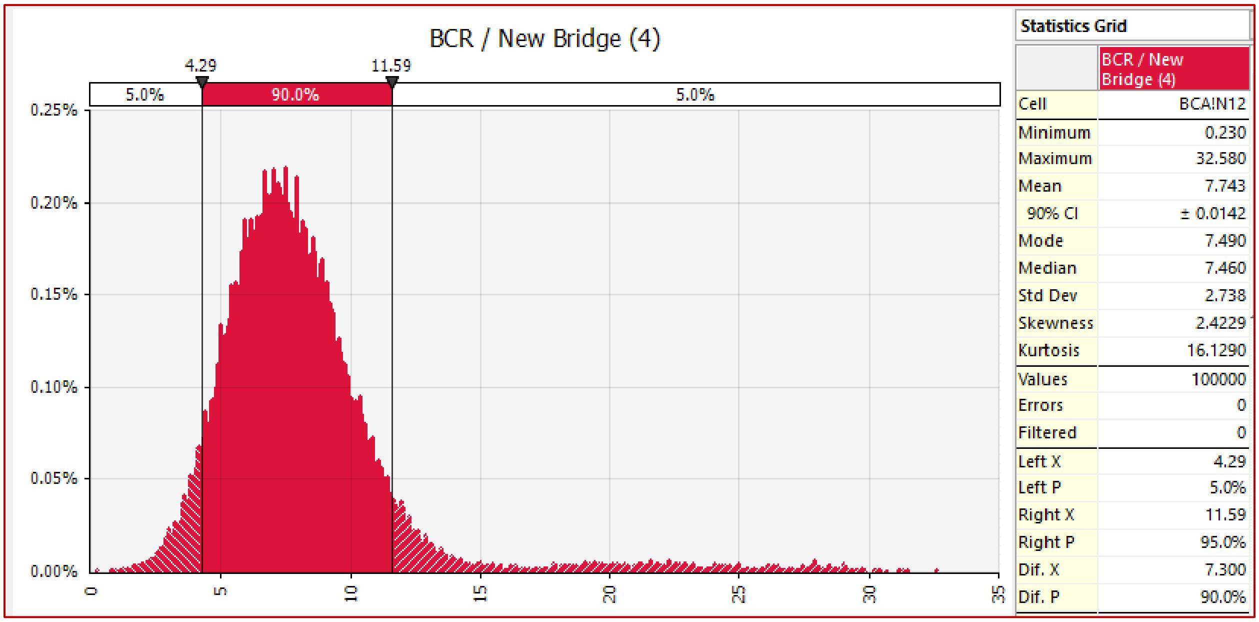
Figure D - 37 below. At the 90% confidence interval, the BCR will be between 4.3 and 11.6, with a median expected outcome of all simulations of 7.5.

Figure D - 38 displays the @RISK results for the net benefits. At the 90% confidence interval, the net benefits will be between $49.9 million and $160.8 million with the median value of $98.1 million.

Table D - 47: Sagamore Bridge Replacement 4 Lanes Annual Costs and BCR

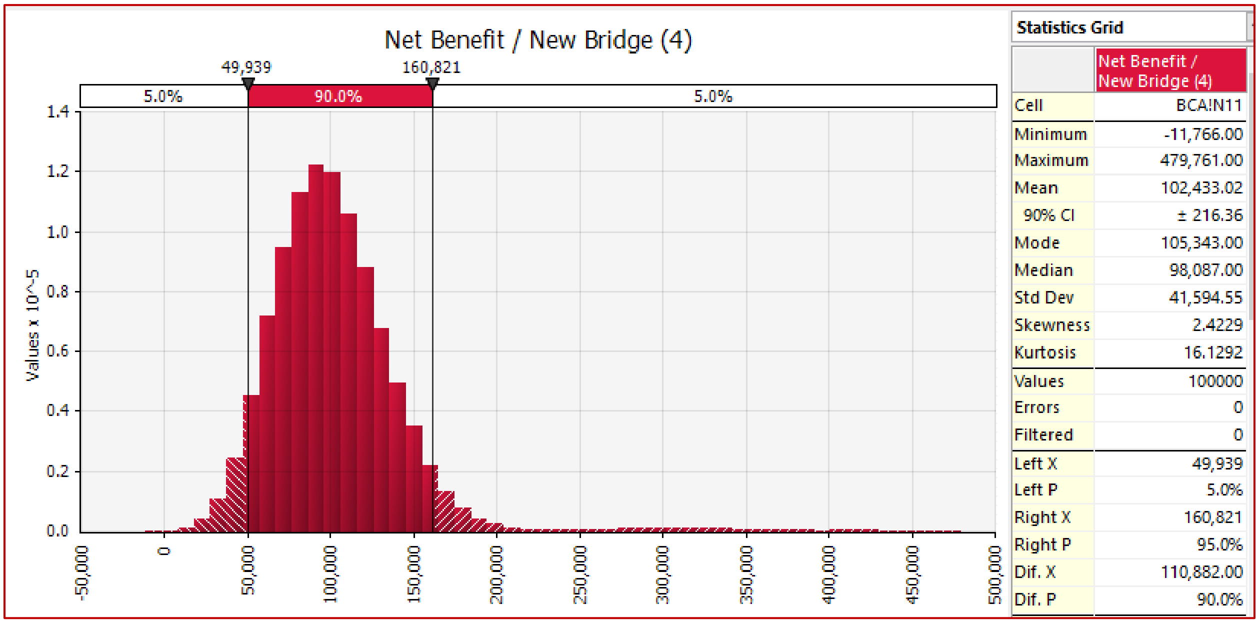
Annual ($000)				
	Benefit	**Cost**	**Net Benefit**	**BCR**
Alternative C	117,600	15,200	102,400	7.7

Figure D - 37: Sagamore 4 Lane Replacement @RISK Output BCR



	BCR / New Bridge (4)
Cell	BCA!N12
Minimum	0.230
Maximum	32.580
Mean	7.743
90% CI	± 0.0142
Mode	7.490
Median	7.460
Std Dev	2.738
Skewness	2.4229
Kurtosis	16.1290
Values	100000
Errors	0
Filtered	0
Left X	4.29
Left P	5.0%
Right X	11.59
Right P	95.0%
Dif. X	7.300
Dif. P	90.0%

Figure D - 38: Sagamore 4 Lane Replacement @RISK Output Net Benefits



	Net Benefit / New Bridge (4)
Cell	BCA!N11
Minimum	-11,766.00
Maximum	479,761.00
Mean	102,433.02
90% CI	± 216.36
Mode	105,343.00
Median	98,087.00
Std Dev	41,594.55
Skewness	2.4229
Kurtosis	16.1292
Values	100000
Errors	0
Filtered	0
Left X	49,939
Left P	5.0%
Right X	160,821
Right P	95.0%
Dif. X	110,882.00
Dif. P	90.0%

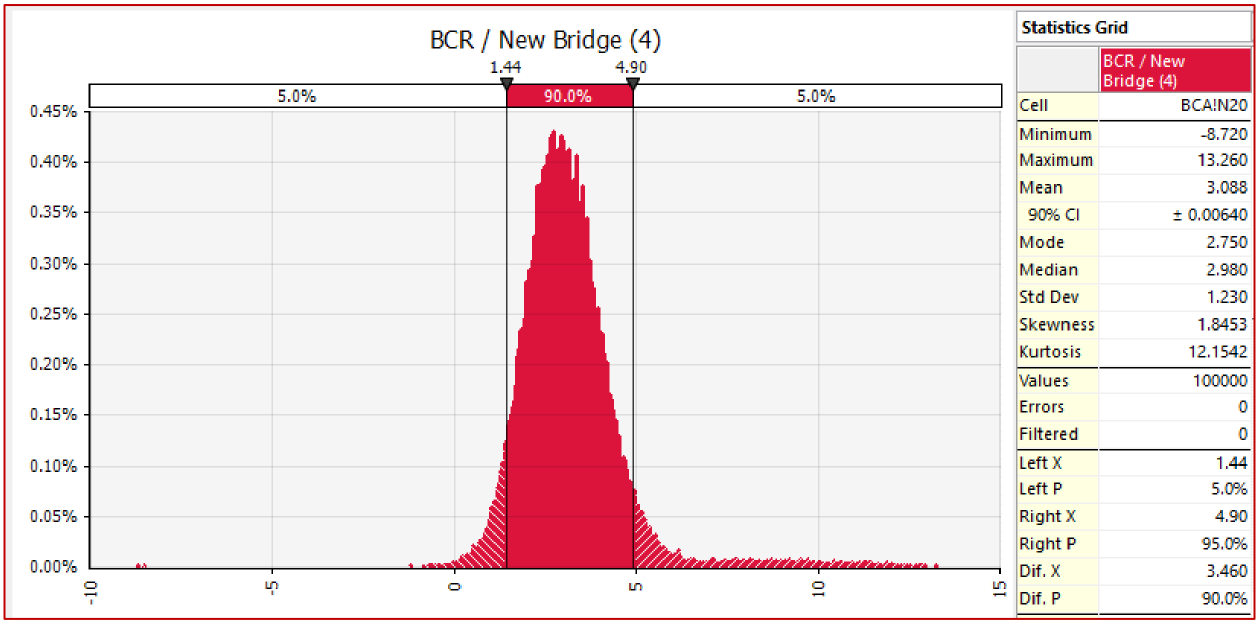
Average annual benefits for the Bourne Bridge replacement amounted to $57.2 million compared to average annual costs of $18.5 million yielding net benefits of $38.7 million. The BCR outcome of the Monte Carlo simulations has a mean of 3.1 and a standard deviation of 1.2 as shown in Figure D - 39 below. At the 90% confidence interval, the BCR will be between 1.4 and 4.9, with a median expected outcome of all simulations of 3.0 (2.98).

Figure D - 40 displays the @RISK results for the net benefits. At the 90% confidence interval, the net benefits will be between $8.2 million and $72.2 million with the median value of $36.7 million.

Table D - 48: Bourne Bridge Replacement 4 Lanes Annual Costs and BCR

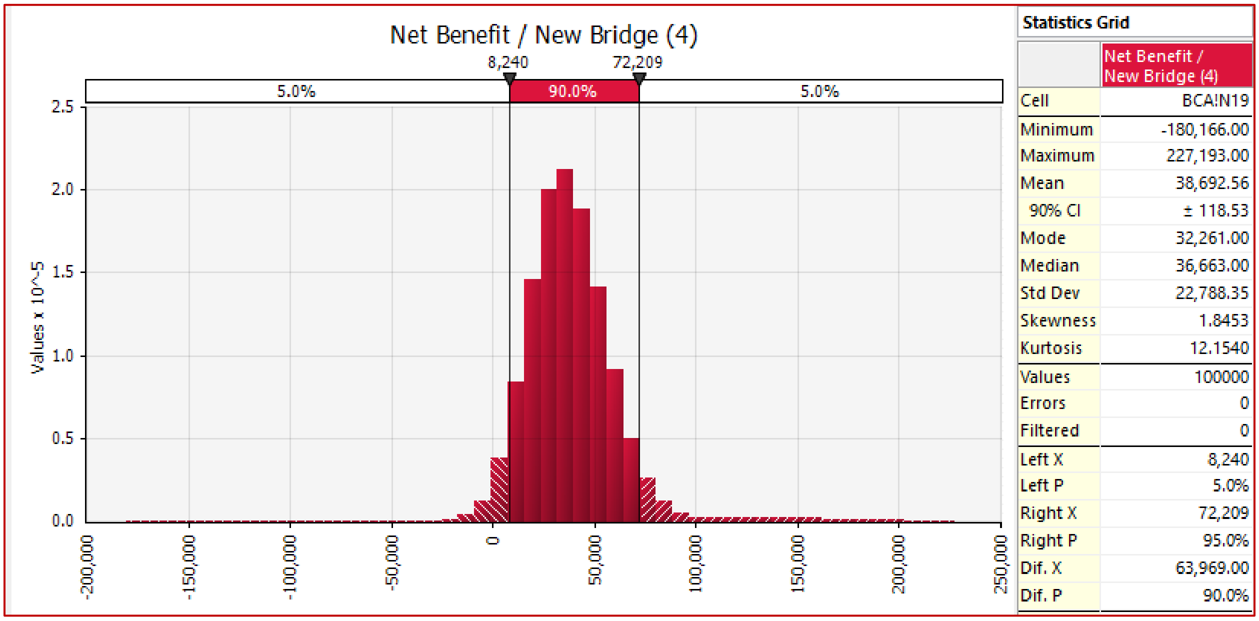
Annual Cost ($000)				
	Benefit	**Cost**	**Net Benefit**	**BCR**
Alternative C	57,200	18,500	38,700	3.1

Figure D - 39: Bourne 4 Lane Replacement @RISK Output BCR



	BCR / New Bridge (4)
Cell	BCA!N20
Minimum	-8.720
Maximum	13.260
Mean	3.088
90% CI	± 0.00640
Mode	2.750
Median	2.980
Std Dev	1.230
Skewness	1.8453
Kurtosis	12.1542
Values	100000
Errors	0
Filtered	0
Left X	1.44
Left P	5.0%
Right X	4.90
Right P	95.0%
Dif. X	3.460
Dif. P	90.0%

Figure D - 40: Bourne 4 Lane Replacement @RISK Output Net Benefits



	Net Benefit / New Bridge (4)
Cell	BCA!N19
Minimum	-180,166.00
Maximum	227,193.00
Mean	38,692.56
90% CI	± 118.53
Mode	32,261.00
Median	36,663.00
Std Dev	22,788.35
Skewness	1.8453
Kurtosis	12.1540
Values	100000
Errors	0
Filtered	0
Left X	8,240
Left P	5.0%
Right X	72,209
Right P	95.0%
Dif. X	63,969.00
Dif. P	90.0%

6.4 Summary of New Bridges Project

The results indicate that replacement of the existing bridges with construction of new 4-lane bridges has a higher benefit to cost ratio than maintaining the bridges in a “fix-as-fails” base condition. In addition, the cost-benefit ratios are also higher than the option to perform a major rehabilitation on the current bridges. The study showed that replacement of both bridges result in positive net benefits and benefit-cost-ratios greater than 1. The impact of traffic delays is a major component in adding economic costs, highlighting the importance of these structures in traffic flows. The replacement alternative limits the impact on traffic which economically outweighs the higher upfront cost.

7 ALTERNATIVE D – REPLACEMENT WITH 4 LANES AND 2 AUXILIARY ON/OFF LANES

In addition to the 4-lane replacement bridge scenario, there is also a proposed alternative to the base condition and the major rehabilitation that is the construction of new bridges adjacent to the current bridges with 4-lanes plus an auxiliary on/off lane in each direction. This scenario has a greater upfront cost but also allows for a more reliable bridge structure that meets current standards and regulations. The proposed bridge would also add one lane on both sides (6 lanes total) to alleviate traffic congestion. The new bridge alternative also includes a wider foot-bridge for walking or bike traffic. The new bridges would not require extended lane and bridge closures and have a lower maintenance cost when compared to the current bridges.

The recommended timeline for the construction of the new bridges is 2025 through 2029 for the Sagamore Bridge and 2030 to 2034 for the Bourne Bridge.

7.1 Benefits

The benefits are the direct and quantifiable gains under the with-project scenario. The new bridges project will improve the reliability of bridge components and therefore significantly decrease the probability of failure. Benefits represent a reduction in emergency repair costs following a component failure and associated time value costs from lane closures related with these repairs. In addition, the new bridges will also have lower annual maintenance costs throughout the 50-year forecast. Modelling these phenomena provides a method to quantify the net benefits for current and future users.

7.1.1 Probability of Unsatisfactory Performance

The probability of failure in this scenario is the same as described in the 4-lane replacement bridges, section 4.1.1.

7.1.2 Probabilistic Scenario Analysis

The event trees used for this scenario are the same as described in the 4-lane replacement bridges, section 4.1.2.

7.1.3 Results of Monte Carlo Simulation

The repair, navigation, and travel costs are determined as described in the existing condition using Monte Carlo Simulation. The results are detailed in Table D - 49 and Table D - 50.

Table D - 49: Sagamore Bridge Replacement 4 Lanes with 2 Auxiliary Annual Costs

Annual Costs (rounded), ($000)					
	Repair Cost	Navigation Cost	Travel Cost	O&M	Total
Alternative D	300	0.1	4,000	200	**4,400**

Table D - 50: Bourne Bridge Replacement 4 Lanes with 2 Auxiliary Annual Costs

Annual Costs (rounded), ($000)					
	Repair Cost	Navigation Cost	Travel Cost	O&M	Total
Alternative D	500	0.2	6,300	200	**7,000**

Benefit of reduced congestion

One additional benefit of the 6-lane replacement bridge is the improved traffic patterns with the additional acceleration/deceleration lane.

A similar method described in section 3.3, using TrafInfo analysis of vehicle hours traveled, was used to compare the value of time in traffic with the 6-lane bridge and compared it to the base condition. The annual total time savings is displayed in Table D - 51.

Table D - 51: Benefits of Reduced Congestion

Cost ($000)			
	Both Replacement Bridges	Sagamore Bridge	Bourne Bridge
Total Benefit	4,200	3,500	800
Annual Benefit	200	100	30

The benefits are fairly minimal due mainly to the fact that the approach infrastructure, owned by the State of Massachusetts, is not assumed to be improved. The current infrastructure, especially around the Bourne Rotary, is limited.

To determine the benefits of the alternative, the cost savings of emergency repairs in the base case and the new bridge alternative are compared by subtracting the costs of new bridge scenario from the base case total costs. The benefits of the replacement bridges are summarized in Table D - 52 and Table D - 53.

Table D - 52: Sagamore Bridge Replacement 4 Lanes with 2 Auxiliary Benefits

Annual Costs, ($000)			
	Total Cost - Base Case	**Total Cost – New Bridges**	**Benefit**
Alternative D	122,100	4,400	117,800

Table D - 53: Bourne Bridge Replacement 4 Lanes with 2 Auxiliary Benefits

Annual Costs, ($000)			
	Total Cost - Base Case	**Total Cost – New Bridges**	**Benefit**
Alternative D	64,200	7,000	57,300

The occurrence of a component failure declines significantly over the study period after the replacement bridges are constructed. Therefore travel delay costs typically associated with these failures similarly are reduced. In addition, annual O&M costs for upkeep of the new bridges is reduced. The measurable benefit of replacing the bridges is the total cost savings of $117.8 million annually for the Sagamore Bridge and $57.3 million annually for the Bourne Bridge.

7.2 Cost of Alternative

There will be limited impact to traffic as the new bridges will be constructed adjacent to the existing bridges. Therefore travel costs will not be included in the analysis.

7.2.1 Engineering Costs

The majority of costs for this alternative will be incurred at the beginning of the construction timeline. The total cost of the construction for the new Sagamore Bridge is $468.6 million (2020 dollars). The total cost of the project for the Bourne Bridge is $696.2 million.

A major rehabilitation or new bridge will not be necessary after 50 years, though there will be subsequent scheduled repairs. The costs of the new bridges and subsequent major repairs are listed in Table D - 54 and Table D - 55.

Table D - 54: Sagamore Bridge Replacement 4 Lanes with 2 Auxiliary Engineering Costs

Sagamore Bridge		
Project	**Years**	**Cost (000) 2020 dollars**
New Bridge	2025-2029	$ 452,800
Major Repairs	2049	$ 7,900
Major Repairs	2069	$ 7,900

Table D - 55: Bourne Bridge Replacement 4 Lanes with 2 Auxiliary Engineering Costs

Bourne Bridge		
Project	**Years**	**Cost (000) 2020 dollars**
New Bridge	2030-2034	$ 688,300
Major Repairs	2054	$ 7,900

7.2.2 Value of Time

There are no expected lane or bridge closures during the construction of the new bridges as they will be constructed adjacent to the existing bridges. The existing bridges will continue to operate until the construction is completed and then traffic will be redirected with minimal impact on traffic delays.

However, during the major repairs that are expected to occur later in the 50-year timeframe, there will be impacts to traffic. For modeling purposes, traffic disruptions are similar to those modeled in Alternative C. Without final bridge design specifications, it is difficult to know the required lane and bridge closures needed for each type of repair work. Assuming closures similar to Alternative C provides a conservative estimate for travel costs as the additional lane will likely reduce congestion during construction. Table D-55 shows the construction costs and associated travel costs.

Table D - 56: Sagamore Bridge Replacement 4 Lanes with 2 Auxiliary Costs

Years	Cost of Construction ($000)	Navigation Cost ($000)	Travel Cost ($000)	Total Cost by Year Incurred ($000)
2025-2029	452,800	200	0	453,000
2049	7,900	0	46,300	54,200
2069	7,900	0	46,300	54,200
Total	468,600	200	92,600	561,400

* Costs are discounted in final analysis

Table D - 57: Bourne Bridge Replacement 4 Lanes with 2 Auxiliary Costs

Years	Cost of Construction ($000)	Navigation Cost ($000)	Travel Cost ($000)	Total Cost by Year Incurred ($000)
2030-2034	688,300	200	0	688,500
2054	7,900	0	22,200	30,100
Total	696,200	200	22,200	718,600

* Costs are discounted in final analysis

7.2.3 Total Annualized Cost

The total costs are annualized to determine the annual cost over the 50 year study. Table D - 58 and Table D-58 exhibit the calculation. The time period used to calculate the interest during construction is 5 years.

Table D - 58: Sagamore Bridge Replacement 4 Lanes with 2 Auxiliary Total Annualized Cost

Cost ($000)	
Construction cost of replacement (2020 dollars)	452,800
Construction cost of additional repair work (2020 dollars)	15,800
Travel and navigation delay costs (2020 dollars)	92,600
Discount factor	2.875%
Capital Recovery Factor	0.0379
Discounted cost of replacement cost	371,600
Discounted additional repair work	5,400
Discounted travel and navigation delay cost	31,900
Interest During Construction (IDC)	26,800
Total Cost	435,900
Annualized Cost	16,500

Table D - 59: Bourne Bridge Replacement 4 Lanes with 2 Auxiliary Total Annualized Cost

Cost ($000)	
Construction cost of replacement (2020 dollars)	688,300
Construction cost of additional repair work (2020 dollars)	7,900
Travel delay and navigation costs (2020 dollars)	22,200
Discount factor	2.875%
Capital Recovery Factor	0.0379
Discounted cost of replacement	490,300
Discounted additional repair work	3,000
Discounted travel delay and navigation cost	8,500
Interest During Construction (IDC)	40,700
Total Cost	542,600
Annualized Cost	20,600

7.3 Bridge Replacement with Acceleration Lanes – Analysis Results

The total benefits from decreased emergency repairs following component failures is compared to the total cost of the new bridge construction which includes engineering costs and scheduled repairs.

7.3.1 Benefit Cost Ratio (BCR)

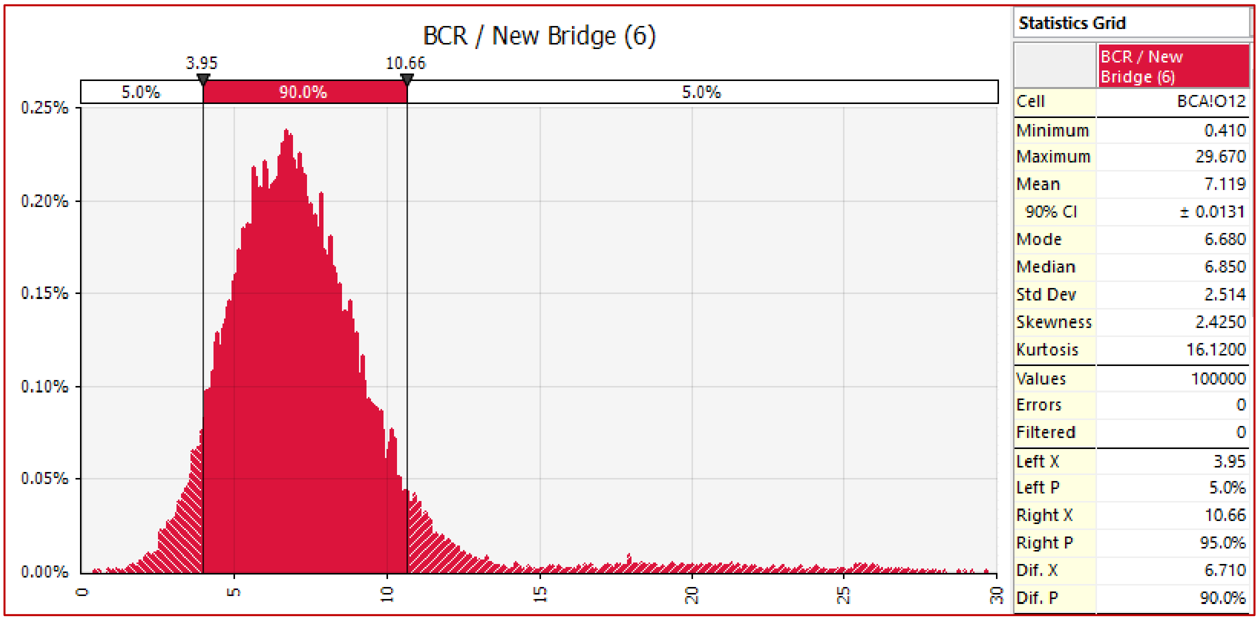
Table D - 60 and Table D - 61 summarize the total benefits, costs, net benefits, and benefit-cost ratios of the replacement project.

Average annual benefits for the Sagamore Bridge replacement amounted to $117.8 million compared to average annual costs of $16.5 million yielding net benefits of $101.2 million. The BCR outcome of the Monte Carlo simulations has a mean of 7.1 and a standard deviation of 2.5 as shown in Figure D-41 below. At the 90% confidence interval, the BCR will be between 4.0 and 10.7, with a median expected outcome of all simulations of 6.9. Figure D - 42 displays the @RISK results for the net benefits. At the 90% confidence interval, the net benefits will be between $48.9 million and $159.7 million with the median value of $96.8 million.

Table D - 60: Sagamore Bridge Replacement 4 Lanes with 2 Auxiliary Annual Cost and BCR

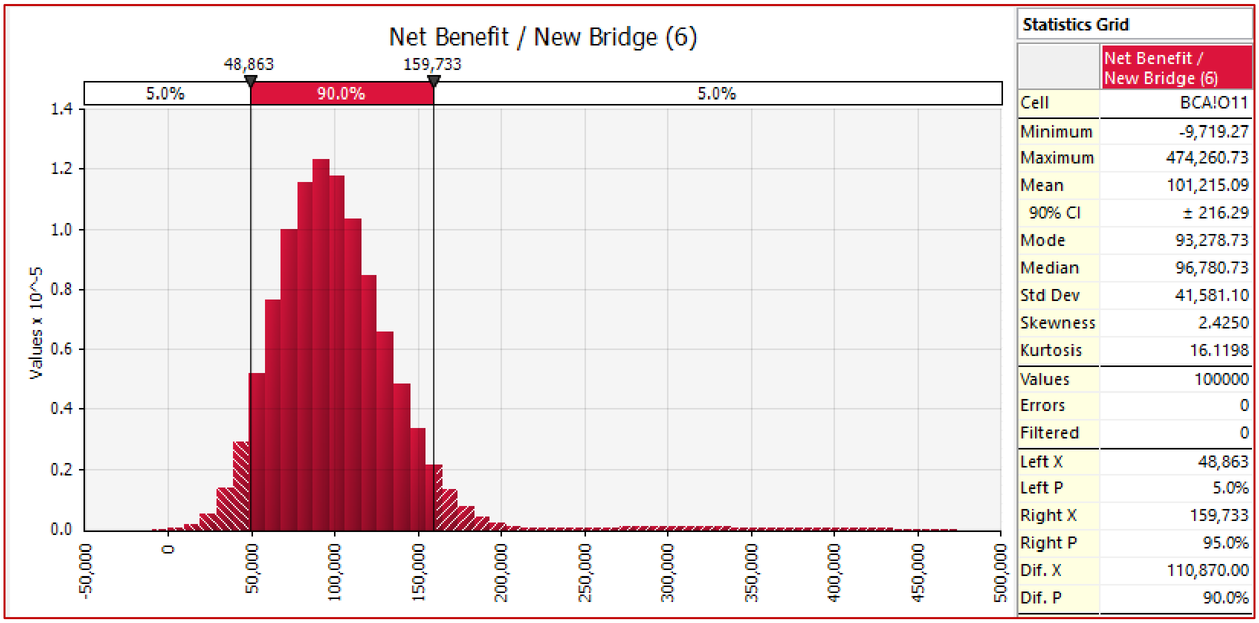
Annual Cost ($000)				
	Benefit	**Cost**	**Net Benefit**	**BCR**
Alternative D	117,800	16,500	101,200	7.1

Figure D - 41: Sagamore 6 Lane Replacement @RISK Output BCR



	BCR / New Bridge (6)
Cell	BCA!O12
Minimum	0.410
Maximum	29.670
Mean	7.119
90% CI	± 0.0131
Mode	6.680
Median	6.850
Std Dev	2.514
Skewness	2.4250
Kurtosis	16.1200
Values	100000
Errors	0
Filtered	0
Left X	3.95
Left P	5.0%
Right X	10.66
Right P	95.0%
Dif. X	6.710
Dif. P	90.0%

Figure D - 42: Sagamore 6 Lane Replacement @RISK Output BCR Net Benefits



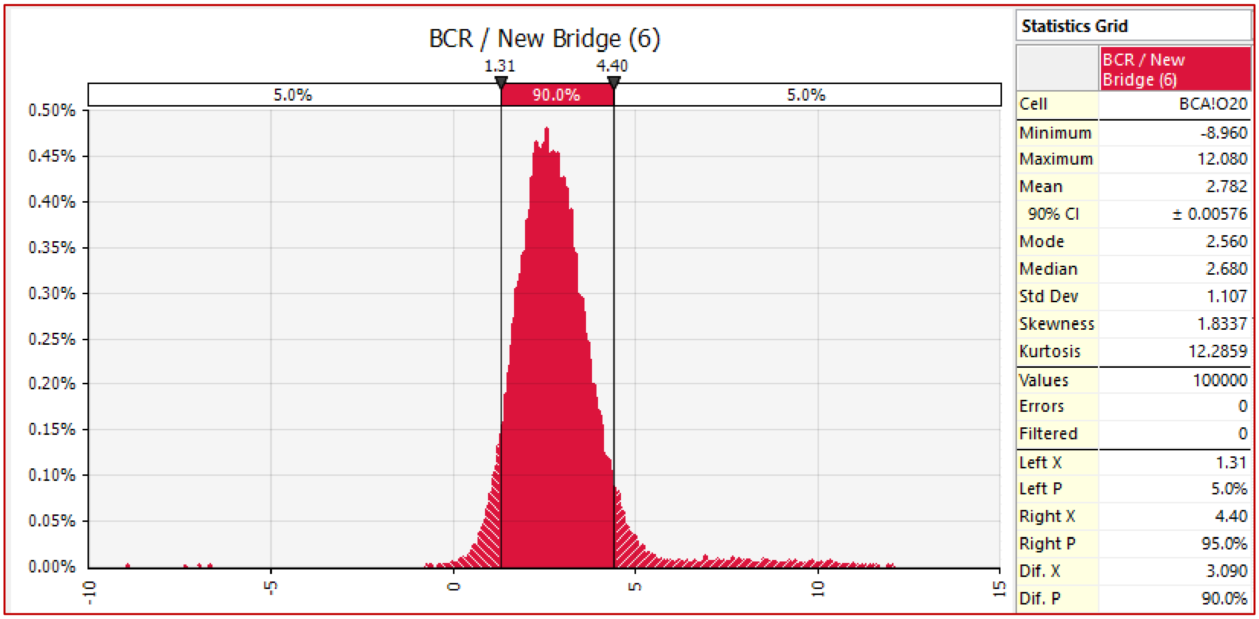
	Net Benefit / New Bridge (6)
Cell	BCA!O11
Minimum	-9,719.27
Maximum	474,260.73
Mean	101,215.09
90% CI	± 216.29
Mode	93,278.73
Median	96,780.73
Std Dev	41,581.10
Skewness	2.4250
Kurtosis	16.1198
Values	100000
Errors	0
Filtered	0
Left X	48,863
Left P	5.0%
Right X	159,733
Right P	95.0%
Dif. X	110,870.00
Dif. P	90.0%

Average annual benefits for the Bourne Bridge replacement amounted to $57.3 million compared to average annual costs of $20.6 yielding net benefits of $36.7 million. The BCR outcome of the Monte Carlo simulations has a mean of 2.8 and a standard deviation of 1.1 as shown in Figure D - 43 below. At the 90% confidence interval, the BCR will be between 1.3 and 4.4, with a median expected outcome of all simulations of 2.7. Figure D - 44 displays the @RISK results for the net benefits. At the 90% confidence interval, the net benefits will be between $6.3 million and $70 million with the median value of $34.6 million.

Table D - 61: Bourne Bridge Replacement 4 Lanes with 2 Auxiliary Annual Cost and BCR

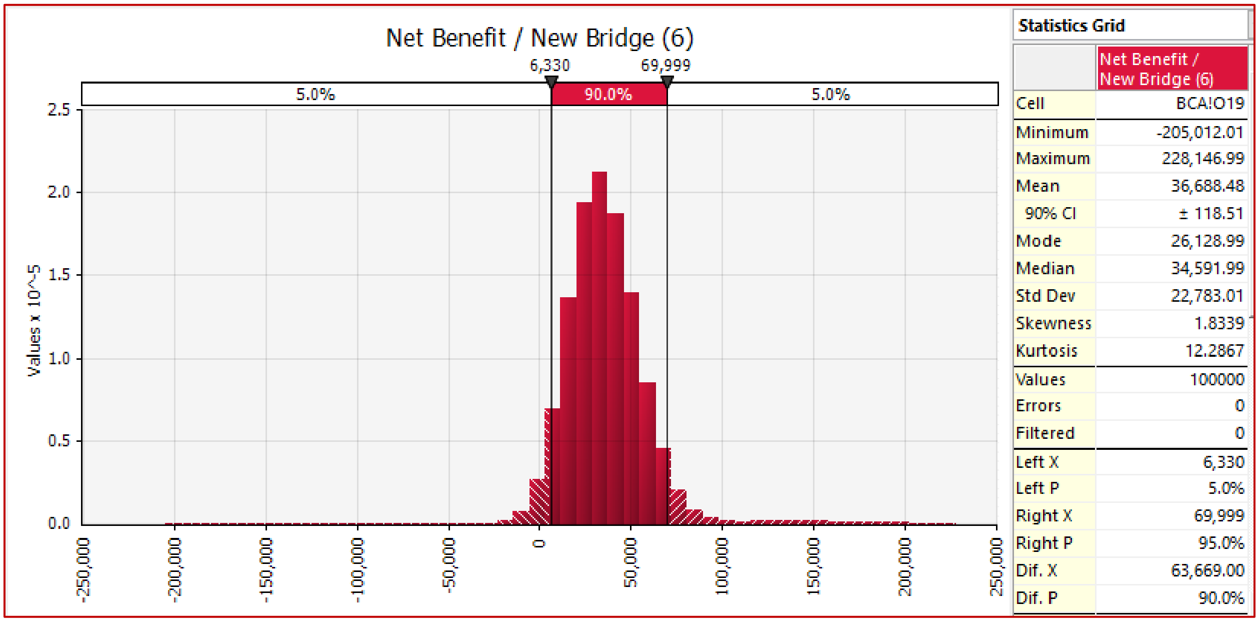
	Annual Cost ($000)			
	Benefit	**Cost**	**Net Benefit**	**BCR**
Alternative D	57,300	20,600	36,700	2.8

Figure D - 43: Bourne 6 Lane Replacement @RISK Output BCR



	BCR / New Bridge (6)
Cell	BCA!O20
Minimum	-8.960
Maximum	12.080
Mean	2.782
90% CI	± 0.00576
Mode	2.560
Median	2.680
Std Dev	1.107
Skewness	1.8337
Kurtosis	12.2859
Values	100000
Errors	0
Filtered	0
Left X	1.31
Left P	5.0%
Right X	4.40
Right P	95.0%
Dif. X	3.090
Dif. P	90.0%

Figure D - 44: Bourne 6 Lane Replacement @RISK Output Net Benefits



	Net Benefit / New Bridge (6)
Cell	BCA!O19
Minimum	-205,012.01
Maximum	228,146.99
Mean	36,688.48
90% CI	± 118.51
Mode	26,128.99
Median	34,591.99
Std Dev	22,783.01
Skewness	1.8339
Kurtosis	12.2867
Values	100000
Errors	0
Filtered	0
Left X	6,330
Left P	5.0%
Right X	69,999
Right P	95.0%
Dif. X	63,669.00
Dif. P	90.0%

7.4 Summary of New Bridges Project

The analysis supports construction of new 6-lane bridges for both bridges over maintaining the bridges in a “fix-as-fails” base condition. In addition, the cost-benefit ratios are also higher than the option to rehabilitate the current bridges. The study showed that both replacement projects result in positive net benefits and benefit-cost-ratios of greater than 1. The BCRs are slightly less than those experienced in the 4-lane replacement bridge scenario, this is due to the more expensive cost to build the bridges.

8 EXTENDED LIFE VALUE

The fifty year study period (2020-2069) is used to compare alternatives with the base condition. Fifty years captures the economic environment expected during that standardized time and does not measure the life of each alternative. It is important to highlight at the end of the fifty-year study period, 2069, the bridges will not be in equal condition across all alternatives. According to the American Association of State Highway and Transportation Office (AASHTO) Load and Resistance Factor Design (LRFD) the design life of bridges constructed today is seventy-five years. Therefore, the replacement bridge alternatives have an expected life significantly beyond the 2069. Given that construction on the replacement Sagamore Bridge is expected to be completed in 2029, the design life of the bridge will be through year 2103. Similarly, the Bourne Bridge is expected to be completed in 2034 and therefore the life of the bridge will be through year 2108. In addition over the fifty year study period there will be two scheduled major repairs that will help to extend the lives of the new bridges.

In contrast, the current bridges have already exceeded seventy-five years. Major rehabilitation projects can extend the life of the bridges but will be required more frequently as time progresses. In addition, the size of the continual rehabilitation projects are significantly more expensive than the scheduled repairs to extend the life of the new replacement bridges.

For more information, sections 3.2.1, 4.1.1, 5.1.1, and 6.1.1 above discuss the probability of unsatisfactory performance by alternative and bridge component. In these sections it is shown that by the end of the study period the probability of failure is not equal across all alternatives with the replacement bridge providing the lowest probabilities of failure at the end of the fifty-year period.

Ultimately, at the end of the study period the bridges for each alternative will not be in equivalent condition. The replacement bridges provide extended life value beyond the base condition and rehabilitation alternative.

9 2020 MODEL UPDATES

The draft version of this Major Rehabilitation or Replacement Evaluation Report was released to the public in October 2019. Following the release, the report was subject to various levels of review both internally and externally as well as public comments. Therefore, some inputs to the economic modelling have been updated. In the following sections (8.1 through 8.7) a summary of the updates are described as well as the final updated model results.

9.1 Elimination of Alternative C

The two existing bridges with their four through traffic lanes were designed and built in the 1930s to serve far lower traffic volumes than those served by the bridges today. Modern highway design guidance, including AASHTO highway and bridge design specifications and MassDOT design guidance require that entrance and exit ramps include auxiliary lanes for entering and exiting traffic to transition into or out of through traffic safely. Today's higher traffic volumes and vehicle speeds require greater distances for traffic to transition. Distance between the on and off ramps, grades, and ramp turn diameters are all typical factors.

The FHWA stated the following in their comment letter:

> *Based on the close proximity of the interchanges and intersections at the end of each bridge, current standards for this type of facility include acceleration and deceleration lanes (also known as auxiliary lanes) going onto the bridges in most, if not all, four ends of the bridges. In final design, analysis will need to be done to determine if the auxiliary lanes should be continuous across each bridge for operational weaving and structural efficiency needs pending on the structure type, long span bridges such as these may gain cost efficiency with a uniform width.*

MassDOT states the following with respect to the need for auxiliary lanes:

> *The design requirements used for the roadways, intersections, and interchanges shall be in accordance with and the 2006 MassDOT Project Development and Design Guide as well as 2018 American Association of State Highway and Transportation Officials (AASHTO) Policy on Geometric Design of Highway and Streets ("the Green Book"). See Chapter 10 of The Green Book which includes Tables 10-4 Minimum Acceleration Lane Lengths for Entrance Terminals…, Table 10-5 Speed Change Lane adjustment factors as a function of grade…, and Table 10-6 Minimum deceleration lane lengths for exit terminals…; these dictate the required lengths for this type of facility include acceleration and deceleration lanes (also known as auxiliary lanes).*

Providing a replacement for the existing spans in-kind with respect to the number of through traffic lanes would not conform to current design guidance for bridges and highways. For this reason, providing new bridges without auxiliary lanes would not be consistent with best practices for traffic safety, and Alternative C will not be carried forward into detailed analysis.

9.2 Update to Discount Rate

The discount rate used to convert future monetary values to present values was updated using the fiscal year 2020 rate of 2.750 percent (compared to 2.875 percent in fiscal year 2019). The associated 2020 capital recovery factor of 0.0370 was included in the model.

9.3 Update to Annual O&M Costs

In the draft release of this Appendix, annual O&M costs were assumed to be $38,000 for both the Bourne and Sagamore Bridges in both Alternative C (4 lane) and Alternative D (4 lane with on/off auxiliary lanes). In this final model run, O&M estimates were re-evaluated for a more accurate estimate. O&M costs were updated to $21,600 annually in Alternative D for the Sagamore Bridge and $36,500 annually for the Bourne Bridge.

9.4 Update to Project Costs

The cost of the major rehabilitation and replacement as well as scheduled major repairs for Alternatives B and D were updated during the Agency Technical Review (ATR), Independent External Peer Review (IEPR), Vertical Team Review (VT), and separate North Atlantic Division Cost Engineer review. For a detailed description of the changes to project costs refer to Appendix C – Cost Engineering. The tables below summarize the new cost numbers.

Alternative B – Major Rehabilitation

Table D - 62: Sagamore Bridge Updated Rehabilitation Engineering Costs

Sagamore Bridge Construction Cost		
Project	**Years**	**Cost (000) 2020 dollars**
Major Rehab	2025-2027	$ 156,300
Complete painting	2045	$ 33,400
Truss Deck Replacement, floor beam repair, complete painting	2065	$ 110,900

The cost of the Sagamore Bridge major rehabilitation increased from $153.3 million to $156.3 million. The complete paining in 2045 increased from $22.9 million to $33.4 million. Finally, the cost of the major repairs in 2065 increased from $82.1 million to $110.9 million.

Table D - 63: Bourne Bridge Updated Rehabilitation Engineering Costs

Bourne Bridge Construction Cost		
Project	**Years**	**Cost (000) 2020 dollars**
Major Rehab	2029-2031	$ 186,200
Complete painting	2049	$ 26,800
Truss Deck Replacement, floor beam repair, complete painting	2069	$ 132,100

The cost of the Bourne Bridge major rehabilitation increased from $155.4 million to $186.2 million. The complete paining in 2049 increased from $19.3 million to $26.8 million. Additionally, the cost of the major repairs in 2069 increased from $95 million to $132.1 million.

Alternative D – Replacement with 4 lanes plus auxiliary on/off lanes

Table D - 64: Sagamore Bridge Replacement 4 Lanes with 2 Auxiliary Updated Engineering Costs

Sagamore Bridge		
Project	**Years**	**Cost (000) 2020 dollars**
New Bridge	2025-2029	$ 486,100
Major Repairs	2049	$ 7,900
Major Repairs	2069	$ 7,900

The cost of replacing the Sagamore Bridge increased from $452.8 million to $486.1 million with subsequent major repairs remaining at $7.9 million.

Table D - 65: Bourne Bridge Replacement 4 Lanes with 2 Auxiliary Updated Engineering Costs

Bourne Bridge		
Project	**Years**	**Cost (000) 2020 dollars**
New Bridge	2030-2034	$ 721,800
Major Repairs	2054	$ 7,900

The cost of replacing the Bourne Bridge increased from $688.3 million to $721.8 million with the major repair in 2054 remaining at $7.9 million.

9.5 8.5 Alternative A Model Results

Table D - 66: Updated Base Condition Life Cycle Costs

Annual Costs (rounded), ($000) FY2020					
	Repair Cost	**Navigation Cost**	**Travel Cost**	**O&M Cost**	**Total**
Sagamore Bridge					
Base Condition	2,800	0.7	120,700	400	**123,900**
Bourne Bridge					
Base Condition	3,200	0.7	61,700	300	**65,200**

Annual costs in Alternative A increased from $122.1 million to $123.9 million for the Sagamore Bridge and increased from $64.2 million to $65.2 million for the Bourne Bridge.

9.6 Alternative B Model Results

Table D - 67: Updated Rehabilitation Life Cycle Costs

Annual Costs (rounded), ($000) FY2020					
	Repair Cost	Navigation Cost	Travel Cost	O&M Cost	Total
Sagamore Bridge					
Alternative B	300	0.6	8,000	400	**8,700**
Bourne Bridge					
Alternative B	400	0.6	5,400	300	**6,100**

Table D - 68: Updated Rehabilitation Benefits

Annual Costs, ($000)			
	Total Life Cycle Cost – Alt. A	Total Life Cycle Cost – Alt. B	Benefit
Sagamore Bridge			
Alternative B	123,900	8,800	115,100
Bourne Bridge			
Alternative B	65,200	6,100	59,100

Table D - 69: Updated Sagamore Bridge Rehabilitation Total Annualized Costs

Sagamore Bridge	
Cost ($000)	
	Alternative B: Rehabilitation
Construction cost (2020 dollars)	156,300
Construction cost of additional repair work (2020 dollars)	144,400
Travel delay costs (2020 dollars)	1,281,000
Discount factor	2.75%
Capital Recovery Factor	0.0370
Discounted construction cost	132,900
Discounted additional repair work	49,700
Discounted travel delay cost	782,600

Interest During Construction (IDC)	4,300
Total Cost	969,500
Annualized Cost	**35,900**

Table D - 70: Updated Bourne Bridge Rehabilitation Total Annualized Costs

Bourne Bridge	
Cost ($000)	
	Alternative B: Rehabilitation
Construction cost (2020 dollars)	186,200
Construction cost of additional repair work (2020 dollars)	158,900
Travel delay costs (2020 dollars)	948,400
Discount factor	2.75%
Capital Recovery Factor	0.0370
Discounted construction cost	142,000
Discounted additional rehab work	47,200
Discounted travel delay cost	536,700
Interest During Construction (IDC)	5,200
Total Cost	731,100
Annualized Cost	**27,100**

Table D - 71: Updated Benefits, Costs, and Benefit-Cost Ratio

Annual ($000)				
	Benefit	**Cost**	**Net Benefit**	**BCR**
Sagamore Bridge				
Alternative B	115,100	35,900	79,200	3.2
Bourne Bridge				
Alternative B	59,100	27,100	32,000	2.2

Updated values resulted in improved net benefits for the Sagamore Bridge major rehabilitation from $77.7 million annually to $79.2 million while net benefits declined slightly for the Bourne

Bridge from $32.3 million annually to $32.0 million. The benefit-cost-ratio (BCR) remained at 3.2 for the Sagamore Bridge and went from 2.3 to 2.2 for the Bourne Bridge.

9.7 Alternative D Model Results

Table D - 72: Updated Replacement Life Cycle Costs

Annual Costs (rounded), ($000) FY2020					
	Repair Cost	Navigation Cost	Travel Cost	O&M Cost	Total
Sagamore Bridge					
Alternative D	300	0.1	4,000	200	**4,500**
Bourne Bridge					
Alternative D	500	0.2	6,300	200	**7,000**

Table D - 73: Updated Replacement Benefits

Annual Costs, ($000)			
	Total Life Cycle Cost – Alt. A	Total Life Cycle Cost – Alt. D	Benefit
Sagamore Bridge			
Alternative D	123,900	4,400	119,500
Bourne Bridge			
Alternative D	65,200	6,900	58,300

Table D - 74: Updated Sagamore Bridge Rehabilitation Total Annualized Costs

Sagamore Bridge	
Cost ($000)	
	Alt D: Replacement 4 Lanes with On/Off Auxiliary
Construction cost (2020 dollars)	486,100
Construction cost of additional repair work (2020 dollars)	15,800
Travel delay costs (2020 dollars)	92,800
Discount factor	2.75%
Capital Recovery Factor	0.0370
Discounted construction cost	402,300
Discounted additional repair work	5,700

Discounted travel delay cost	33,500
Interest During Construction (IDC)	27,500
Total Cost	469,000
Annualized Cost	**17,400**

Table D - 75: Updated Bourne Bridge Rehabilitation Total Annualized Costs

Bourne Bridge	
Cost ($000)	
	Alt D: Replacement 4 Lanes with On/Off Auxiliary
Construction cost (2020 dollars)	721,800
Construction cost of additional repair work (2020 dollars)	7,900
Travel delay costs (2020 dollars)	22,200
Discount factor	2.75%
Capital Recovery Factor	0.0370
Discounted construction cost	521,600
Discounted additional rehab work	3,100
Discounted travel delay cost	8,900
Interest During Construction (IDC)	40,800
Total Cost	574,400
Annualized Cost	**21,300**

Table D - 76: Updated Benefits, Costs, and Benefit-Cost Ratio

Annual ($000)				
	Benefit	**Cost**	**Net Benefit**	**BCR**
Sagamore Bridge				
Alternative D	119,500	17,400	102,100	6.9
Bourne Bridge				
Alternative D	58,300	21,300	37,000	2.7

Revisions to model inputs resulted in improved net benefits for both bridges. The Sagamore Bridge had net benefits increase from $101.2 million annually to $102.1 million while the Bourne Bridge net benefits went from $36.7 million annually to $37.0 million. The benefit-cost-ratio (BCR) dropped from 7.1 for the Sagamore Bridge and went from 2.8 to 2.7 for the Bourne Bridge.

10 SUMMARY OF RESULTS

10.1 Tables and Charts

Table D - 77: Sagamore Bridge Summary Results

Scenario Simulation Comparison					
	Annual Life Cycle Cost* ($000) (from Table 1)	**Annualized Costs ($000)** (from Table 2)	**Annualized Benefits ($000)**	**Annualized Net Benefits ($000)**	**BCR**
Alt A: Base Condition					
Mean	123,900	-	-	-	-
Median	119,000	-	-	-	-
Alt B: Major Rehabilitation					
Mean	8,800	35,900	115,100	79,200	3.2
Median	6,600	35,900	112,400	76,500	3.1
Alt D: Replacement 4 Lanes with on/off Auxiliary					
Mean	4,400	17,400	119,500	102,100	6.9
Median	2,900	17,400	116,100	98,700	6.7

Table D - 78: Bourne Bridge Summary Results

Scenario Simulation Comparison					
	Annual Life Cycle Cost* ($000) (from Table 1)	**Annualized Costs ($000)** (from Table 2)	**Annualized Benefits ($000)**	**Annualized Net Benefits ($000)**	**BCR**
Alt A: Base Condition					
Mean	65,200	-	-	-	-
Median	62,700	-	-	-	-
Alt B: Major Rehabilitation					
Mean	6,100	27,100	59,100	32,000	2.2
Median	4,800	27,100	57,900	30,800	2.1
Alt D: Replacement 4 Lanes with on/off Auxiliary					

Mean	6,900	21,300	58,300	37,000	2.7
Median	4,200	21,300	58,500	37,200	2.7

10.2 Rank of Alternatives

Based on BCRs and Net Benefits, the rank of alternatives (with 1 being the most desirable) is:

1. Replacement bridges – 4 lanes with 2 auxiliary on/off lanes (Alternative D)
2. Rehabilitation of bridges (Alternative B)
3. Fix as fails base condition (Alternative A)

10.3 Conclusion

The Sagamore and Bourne Bridges connect mainland Massachusetts to Cape Cod and provide vital routes of transportation for both residents and travelers on and off the Cape. The economic analysis suggests that fixing the current bridges as components deteriorate will lead to significant costs, particularly costs for travelers delayed in traffic.

The first alternative evaluated was major rehabilitation of the existing bridges. This scenario was supported by positive net benefits and a benefit-cost-ratio of 3.2 for the Sagamore Bridge and 2.2 for the Bourne Bridge. The advantage of the rehabilitation is a lower initial construction cost for the project when compared to replacing the bridges. The disadvantages are the high impact it will have on traffic patterns during the time of construction due to lane and full bridge closures. In addition, the bridges will not be brought up to current engineering standards and regulations. The major rehabilitation alternative is a higher risk option due to the faster rate of deterioration in the future. Deterioration of these structures can increase exponentially as these bridges age and may warrant the need for replacement in the future.

Alternatives for replacement bridges were also evaluated for 4-lane bridges (Alternative C) and for 4-lane bridges with auxiliary on/off lanes (Alternative D). Alternative C was eliminated as this design will not meet current highway safety requirements. Alternative D had higher net benefits and BCRs than the rehabilitation scenario. The disadvantage of the replacement bridges is the high initial cost of construction. The advantages of the replacement bridges are minimal disturbances to traffic during construction and replacing the aging infrastructure with bridges at current engineering standards and regulations.

The analysis suggests that the 4-lane bridges with auxiliary on/off lanes (Alternative D) are more economically justifiable given the lower annual costs over 50 years of analysis.

11 APPENDIX

11.1 Assumptions

Assumptions include:

Value of Time Calculation

- There was an assumption in the calculation done for Regulars and Visitors. Regulars live in the four surrounding towns of the bridges and visitors uses the Massachusetts state average household income.
- Visitors: average of vacation, social/recreation, and other (or all other activities not considered vacation, social/recreational, or work)
- Regular: average of work, social/recreation, and other
- Traffic volumes increase linearly from 2014 to 2040 then are held constant after 2040. The final year of forecast provided by TrafInfo is 2040.
- Visitor trips within each trip table were projected from 2014 to 2040 using an annual growth rate of 0.7% or a factor of 1.2 over the 26 year horizon. As part of the MassDOT's Cape Cod Canal Crossing Study project, a detailed assessment was conducted into employment trends in Accommodations and Food Services as a proxy for visitor activity. A regression model was developed relating employment in Accommodations and Food Services with traffic volumes over the Bourne and Sagamore Bridges. The analysis indicated the visitor growth to be in the range of 0.12% to 0.7%. Based on discussions with the Cape Cod Commission and their inhouse estimates of visitor growth, the high end growth rate was used to allow for a more conservative analysis of the necessary highway improvements and to ensure the growth potential in the Cape was not constrained by the proposed highway infrastructure. The same factor was applied to all time periods and during both weekday and weekend.
- The non-visitor trip tables were projected using a three-step process. MassDOT Planning provided the population, household and employment projections for each TAZ for the year 2040. The employment data was broken into retail and non-retail employment. Using trip generation equations contained within the model, total trips generated at each TAZ were computed. The trip generation equations estimate the number of Home-Based Work (HBW) trips, Home-Based Other (HBO) trips, and Non Home-Based (NHB) trips. Each of these trip trips are broken into productions and attractions. The six trip types were computed for each of the four time periods (AM, MD, PM and NT) and were combined to obtain the total trips generated by each TAZ in 2014 and in 2040 for each time period.
- Expected travel times per vehicle over the major routes cannot exceed the given study time period. For example, the "AM" study period is between 6:00 AM to 9:00 AM therefore average travel times during this period are capped at 180 minutes.
- Real income was held constant over the 50 year study period. Though real income is likely to increase over time, holding real income constant is a more conservative estimate. Increasing income overtime would increase the value of time costs and therefore make travel costs associated with construction especially in Alternative A (base condition) and Alternative B (rehabilitation) larger. The results would not change the final recommendation for replacement of the bridges.

- Volume of traffic held constant over the alternatives – in reality, travelers will likely choose not to travel over the bridge in the case of closures but held volume constant for comparison. There is the exception in peak summer time periods during closures where the number of trips decreased slightly as roads either met their capacity or drivers seek alternate routes to cross the bridges.
- For modeling purposes, traffic disruptions for Alternative D are similar to those modeled in Alternative C. Without final bridge design specifications, it is difficult to know the required lane and bridge closures needed for each type of repair work. Assuming closures similar to Alternative C provides a conservative estimate for travel costs as the additional lane will likely reduce congestion during construction. This assumption does not change the final recommendation for replacement bridges.

Monte Carlo Model

- Emergency repair costs are incurred in year of failure
- Rehabilitation will reduce hazard years in reliability functions while replacement will reset functions. Existing condition will continue to deteriorate.
- All values in real 2020 dollars but discounted over time and final values annualized for comparison
  - A rating of 4 or below may trigger the need for a repair, however, the year in which costs are allocated and when the repair work is completed can vary depending a variety of factors including severity and budgetary constraints. If the “failure” is minimal the repair work could take several years for funding to be approved and construction to begin. For more severe failures, emergency funds could be approved and implemented more quickly. A detailed description of the current and historical ratings of the bridge components can be found in Appendix A-Engineering Reliability, section 4. Given the uncertainty and complexity of predicting when funds and repairs will occur, the economic modeling assumes costs and improvements are triggered in the same year as the component failure. This assumption could overestimate minor failure costs if those were to be delayed for several years as costs are discounted in future years. The impact will not be significant and will not change the final recommendation of this report as the assumption is held constant for all alternatives modeled. Additionally, in the base condition where there are more instances of failures, there is also a higher likelihood of severe failures in later years that will need to be addressed promptly.

11.2 Sensitivity Analysis

Sensitivity analysis was performed to confirm that the assumptions underlying the model were appropriate. The sensitivity analysis in sections 10.1.1 through 10.1.5 were performed prior to the 2020 updated values described in section 8. Given there was minimal change in the resulting net benefits and BCRs, the sensitivity analysis is considered appropriate and updating the values would not change the conclusions.

11.2.1 Sensitivity Analysis on the Hazard Functions

One topic of discussion between the economics, engineering, and risk team members was the effect of emergency repairs on the hazard functions. In early versions of the model, the hazard rates were reset or brought back a number of years in order to show that if repairs were done, the reliability of the bridge was improved. However, after further discussion the team determined that this method was lacking for two reasons. First, there can be a failure on one part of the bridge component and the repair does not fix the entire component and another failure can occur in the subsequent year on another section of the same component. Second, resetting the hazard rates was not accurately capturing a deteriorating base condition and not accurately showing how the bridge would weaken in the later years of the forecast horizon.

To test the sensitivity of changes to the reset of the hazard functions, the model was run with a maximum and minimum reset of the hazard functions after a component failure, holding all else constant. The resulting BCRs are shown in Table D-63.

The maximum reset (HF Reset Max) calls for repairs after a failure in the superstructure and substructures to reset the hazard year 20 years respectively, repairs after failures in the bridge deck resets the hazard year back to hazard year 1.

The minimum reset (HF Reset Min) scenario is a more conservative estimate in which all repairs after a component failure reset the hazard year back 10 years.

Table D - 79: Sensitivity Analysis Hazard Functions Mean BCRs

	Major Rehabilitation (Alt B)	Replacement Bridge 4 Lanes (Alt C)	Replacement Bridge 4 Lanes with Auxiliary Lanes (Alt D)
Sagamore			
Selected Scenario	3.2	7.7	7.1
HF Reset Max	0.4	1.2	1.1
HF Reset Min	0.8	2.2	2.0
Bourne			
Selected Scenario	2.3	3.1	2.8
HF Reset Max	0.3	0.4	0.4
HF Reset Min	0.5	0.8	0.7

Resetting the hazard function following an emergency repair had notable impact on the BCRs. The replacement BCRs remained higher than the major rehabilitation scenario's BCRs and were positive with both the maximum and minimum reset options in the Sagamore Bridges. As mentioned previously, the justification for ultimately not resetting the hazard functions was based on engineering expertise in which resetting the functions did not accurately portray a deteriorating bridge in the later years of the study.

11.2.2 Sensitivity Analysis on the Event Tree Probabilities

After determining that the hazard function should not be reset, the event tree probabilities, particularly the later existing condition years, were examined. In the later years of the base condition, the bridges should deteriorate with increasing severity but not experience an unrealistic number of severe failures.

The substructure probabilities remained at 90% of widespread deterioration if there was a substructure failure in any year, and 10% probability that it will be severe deterioration of the substructure. The existing condition conditions for the superstructure and bridge deck were investigated based on advice from engineering and risk experts.

Table D - 80 examines the mean BCRs of the review.

Table D - 80: Sensitivity Analysis Event Tree Probabilities Mean BCRs

	Major Rehabilitation (Alt B)	**Replacement Bridge 4 Lanes (Alt C)**	**Replacement Bridge 4 Lanes with Auxiliary Lanes (Alt D)**	**Average Critical/adv Failures over 50 Years**
Sagamore				
Scenario 1	4.5	11.6	10.6	7.9 superstructure 3.7 bridge deck
Scenario 2	3.8	9.8	9.0	5.8 superstructure 3.7 bridge deck
Scenario 3	3.3	8.6	7.9	4.3 superstructure 3.7 bridge deck
Scenario 4	4.4	11.5	10.6	7.9 superstructure 3.1 bridge deck
Selected Scenario	3.2	7.7	7.1	4.3 superstructure 3.1 bridge deck
Bourne				
Scenario 1	3.4	4.9	4.4	7.9 superstructure 3.8 bridge deck
Scenario 2	2.8	4.0	3.6	5.8 superstructure 3.8 bridge deck
Scenario 3	2.4	3.5	3.1	4.4 superstructure 3.8 bridge deck

Scenario 4	3.3	4.8	4.3	7.9 superstructure 3.1 bridge deck
Selected Scenario	2.3	3.1	2.8	4.4 superstructure 3.1 bridge deck

Scenario 1: Superstructure probability of non-critical failure at 0.9, critical failure at 0.0999, and catastrophic failure at 0.0001 in years 2020-2030. Superstructure probability of non-critical failure at 0.45, critical failure at 0.549, and catastrophic failure at 0.001 in years after 2030. Bridge deck probability of localized deterioration at 0.8 and widespread at 0.2 in years 2020-2030. Bridge deck probability of localized deterioration at 0.45 and widespread at 0.55 in after 2030.

Scenario 2: Superstructure probability of non-critical failure at 0.9, critical failure at 0.0999, and catastrophic failure at 0.0001 in years 2020-2030. Superstructure probability of non-critical failure at 0.6, critical failure at 0.399, and catastrophic failure at 0.001 in years after 2030. Bridge deck probability of localized deterioration at 0.8 and widespread at 0.2 in years 2020-2030. Bridge deck probability of localized deterioration at 0.45 and widespread at 0.55 in after 2030.

Scenario 3: Superstructure probability of non-critical failure at 0.9, critical failure at 0.0999, and catastrophic failure at 0.0001 in years 2020-2030. Superstructure probability of non-critical failure at 0.7, critical failure at 0.299, and catastrophic failure at 0.001 in years after 2030. Bridge deck probability of localized deterioration at 0.8 and widespread at 0.2 in years 2020-2030. Bridge deck probability of localized deterioration at 0.45 and widespread at 0.55 in after 2030.

Scenario 4: Superstructure probability of non-critical failure at 0.9, critical failure at 0.0999, and catastrophic failure at 0.0001 in years 2020-2030. Superstructure probability of non-critical failure at 0.45, critical failure at 0.549, and catastrophic failure at 0.001 in years after 2030. Bridge deck probability of localized deterioration at 0.8 and widespread at 0.2 in years 2020-2030. Bridge deck probability of localized deterioration at 0.55 and widespread at 0.45 in after 2030.

Selected Scenario: Superstructure probability of non-critical failure at 0.9, critical failure at 0.0999, and catastrophic failure at 0.0001 in years 2020-2030. Superstructure probability of non-critical failure at 0.7, critical failure at 0.299, and catastrophic failure at 0.001 in years after 2030. Bridge deck probability of localized deterioration at 0.8 and widespread at 0.2 in years 2020-2030. Bridge deck probability of localized deterioration at 0.55 and widespread at 0.45 in after 2030.

After analyzing the results and reviewing the average number of failures for each scenario it was determined that the more conservative estimate listed in Table D-70 as “Selected Scenario” was the best option.

11.2.3 Sensitivity Analysis on Project Start Year

Another analysis was performed on the project start date, moving out the start date of the rehabilitation and replacement projects three and five years to determine the optimal starting period. For the rehabilitation the Sagamore Bridge project was pushed out from 2025 to 2028 and 2030 respectively. The major rehabilitation for the Bourne Bridge was moved from 2029 to 2031 and 2034 respectively. For the replacement bridge scenario, the start of construction on the Sagamore Bridge was adjusted from 2025 to 2028 and 2030. The start of construction for the Bourne replacement bridge was pushed out from 2030 to 2033 and 2035. The analysis was still performed over 50 years 2020-2069. Table D-81 displays the results of the mean BCRs.

Table D - 81: Sensitivity Analysis Project Start Year Mean BCRs

	Major Rehabilitation (Alt B)	**Replacement Bridge 4 Lanes (Alt C)**	**Replacement Bridge 4 Lanes with Auxiliary Lanes (Alt D)**
Sagamore			
Selected Scenario	3.2	7.7	7.1
Start date out 3 years	3.1	8.5	7.8
Start date out 5 years	3.6	8.9	8.1
Bourne			
Selected Scenario	2.3	3.1	2.8
Start date out 3 years	2.9	3.5	3.2
Start date out 5 years	2.6	3.4	3.0

Moving the start date out three or five years had a minimal impact on the BCRs. The slight positive response when dates are moved out correlates to the shifting of some scheduled maintenance in the further out years that no longer are in the fifty year study period.

11.2.4 Sensitivity Analysis on the Value of Time

The value of time calculation used to determine the cost of travelers stuck in traffic during emergency and planned construction included assumptions. The first assumption was to hold the forecast 2040 vehicle hours traveled (VHT) constant for years after 2040. To test the sensitivity of this assumption, the VHTs were linearly expanded for years after 2040 and the model was run again holding all else constant. Results for changes in BCRs are shown in Table D-66.

The second assumption made in the value of time calculation was to equally weight regulars as the average of social/recreational, work, and other while visitors were the average or social/recreational, other, and vacation. To test the sensitivity of these weights, the regulars were set to just work and the visitors were just vacationers. Both instances were looked at individually then again together to determine how much this assumption impacted the final BCRs. The results are shown in Table D-82.

Table D - 82: Sensitivity Analysis Value of Time Mean BCRs

	Major Rehabilitation (Alt B)	Replacement Bridge 4 Lanes (Alt C)	Replacement Bridge 4 Lanes with Auxiliary Lanes (Alt D)
Sagamore			
Selected Scenario	3.2	7.7	7.1
VHT linearly grown	4.0	12.1	11.1
Regulars – all work	3.2	7.8	7.1
Visitors – all vacation	3.2	8.1	7.5
Regulars – all work, and Visitors – all vacation	3.2	8.0	7.2
Bourne			
Selected Scenario	2.3	3.1	2.8
VHT linearly grown	2.9	4.6	4.1
Regulars – all work	2.3	3.2	2.8
Visitors – all vacation	2.3	3.3	3.0
Regulars – all work, and Visitors – all vacation	2.3	3.2	3.0

After analyzing the value of time assumption in the model it was determined that the assumptions were not extremely sensitive to changes and the selected assumptions tended on the more conservative side.

11.2.5 Sensitivity Analysis on Concurrent Replacement Bridge Construction

Rehabilitation construction work cannot occur concurrently on both bridges given the need for lane and bridge closures. For this reason, it is proposed that the Sagamore Bridge undergoes the major rehabilitation starting in 2025, once completed there will be one year break from construction to allow some reprieve from traffic woes before commencement starts again on the Bourne Bridge starting in 2029.

In the replacement alternatives the assumption was made to construct the replacement Sagamore Bridge first starting in 2025 and once completed commence the construction to build the replacement Bourne Bridge in 2030. This assumption was made because there may be limited resources (ie. funding, construction personal, and/or equipment) and therefore there may only be capacity to build one bridge at a time.

If resources were made available, the two replacement bridges could be constructed at the same time since there is no impact on traffic. Under this scenario both replacement projects would start in 2025 and be completed in 2029. This has no impact on the BCR for the Sagamore Bridge but would shift up the construction date of the Bourne Bridge. The resulting BCRs of this analysis is in Table D - 83 below.

Table D - 83: Sensitivity Analysis Replacement Bridges Built Concurrently

	Replacement Bridge 4 Lanes (Alt C)	Replacement Bridge 4 Lanes with Auxiliary Lanes (Alt D)
Sagamore		
Selected Scenario	7.7	7.1
Bridges Built Concurrently	7.7	7.1
Bourne		
Selected Scenario	3.1	2.8
Bridges Built Concurrently	2.8	2.6

Shifting the start date of the replacement Bourne Bridge construction to 2025 has a minor negative impact on the BCR. The study period remained the same (2020-2069) and therefore if construction is completed in 2029 there will be additional repair work required every twenty years at 2049 and 2069 as compared to the selected scenario which only had one additional repair during the study period.

11.2.6 Sensitivity Analysis on Weight Restrictions

In the instance of a superstructure failure when there is an advanced deterioration of the main truss member or critical gusset plate, there will be 18 months of lane closures and trucks over 16 ton will be diverted to the sister bridge. The analysis estimates that 6% of traffic are trucks over 16 tons according to a MassDOT estimate. The model therefore routes 6% of traffic to the sister bridge, as if there is a full bridge closure for 12 months. The review process brought to light the concern that this method may be overstating the traffic implications for those trucks as traffic will not be as significant as a full bridge closure. In addition, in some instances two smaller trucks may be used in place of the larger trucks. To test the impact of this assumption a sensitivity analysis was performed.

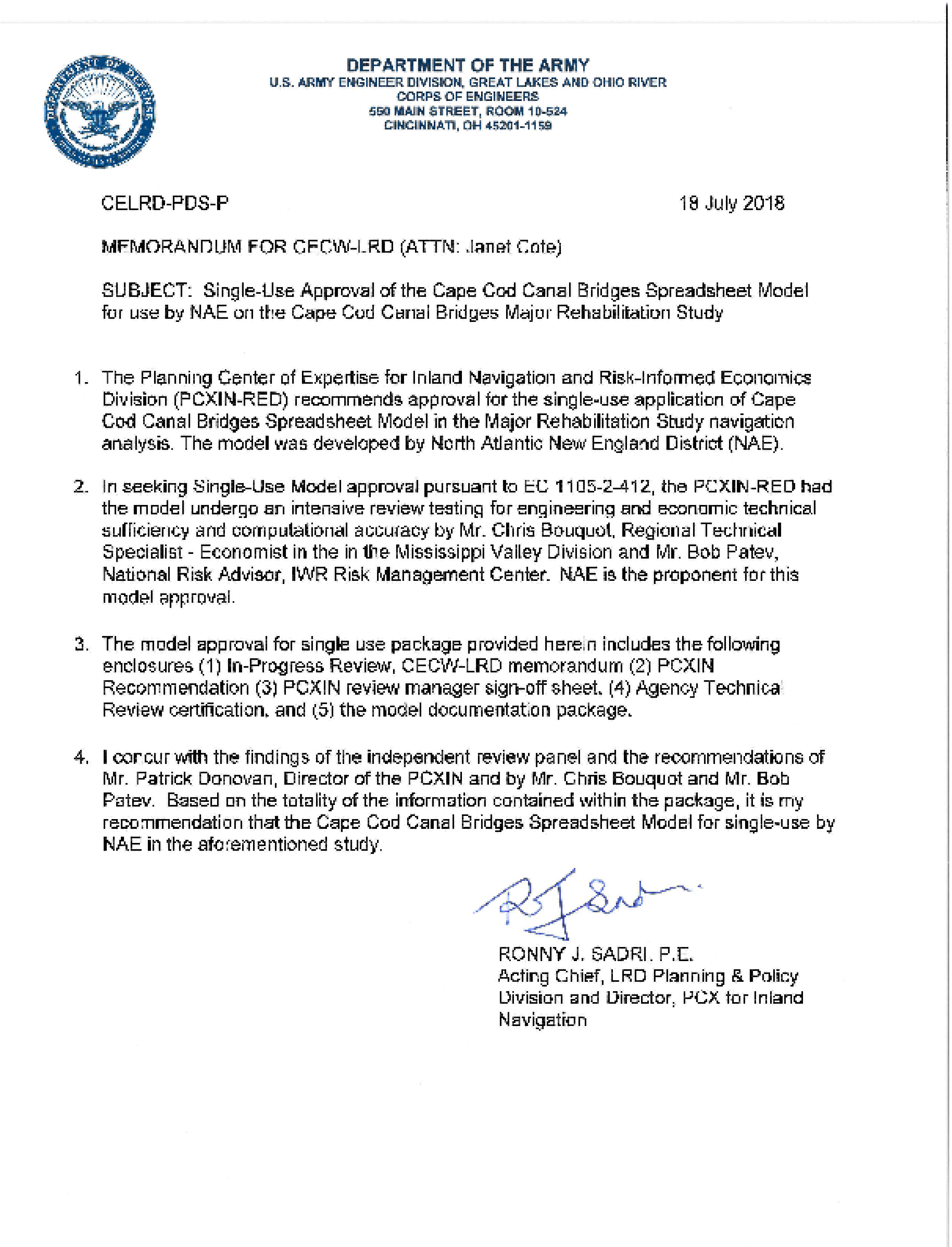
First a sensitivity model (SA 1 in table below) was run as if all traffic was limited by a lane closure. This assumes two smaller trucks would be used in the place of one larger truck. The volume was held constant as there are capacity limitations. This model therefore will likely underestimate the cost to trucks in traffic.

The second sensitivity model (SA 2 in table below) was run in which 6% of traffic was rerouted to a free-flowing second bridge. This similarly underestimates the cost to trucks.

Table D - 84: Sensitivity Analysis Weight Restrictions

	Major Rehabilitation (Alt B)	Replacement Bridge 4 Lanes with Auxiliary Lanes (Alt D)
Sagamore		
Selected Scenario	3.2	6.9
SA 1	2.9	6.3
SA 2	2.8	6.2
Bourne		
Selected Scenario	2.2	2.7
SA 1	2.0	2.5
SA 2	2.0	2.3

The complexity of rerouting a percentage of traffic is difficult to accurately model within the traffic modeling framework. The assumption used in the main methodology is likely to overstate the impact of traffic while the methods used in the sensitivity analysis likely underestimate the impact of traffic. Ultimately, however the assumption used in the report does not impact the final conclusion made within the report. Replacement provides the highest benefits.



DEPARTMENT OF THE ARMY
U.S. ARMY ENGINEER DIVISION, GREAT LAKES AND OHIO RIVER
CORPS OF ENGINEERS
550 MAIN STREET, ROOM 10-524
CINCINNATI, OH 45201-1159

CELRD-PDS-P 18 July 2018

MEMORANDUM FOR CECW-LRD (ATTN: Janet Cote)

SUBJECT: Single-Use Approval of the Cape Cod Canal Bridges Spreadsheet Model for use by NAE on the Cape Cod Canal Bridges Major Rehabilitation Study

1. The Planning Center of Expertise for Inland Navigation and Risk-Informed Economics Division (PCXIN-RED) recommends approval for the single-use application of Cape Cod Canal Bridges Spreadsheet Model in the Major Rehabilitation Study navigation analysis. The model was developed by North Atlantic New England District (NAE).

2. In seeking Single-Use Model approval pursuant to EC 1105-2-412, the PCXIN-RED had the model undergo an intensive review testing for engineering and economic technical sufficiency and computational accuracy by Mr. Chris Bouquot, Regional Technical Specialist - Economist in the in the Mississippi Valley Division and Mr. Bob Patev, National Risk Advisor, IWR Risk Management Center. NAE is the proponent for this model approval.

3. The model approval for single use package provided herein includes the following enclosures (1) In-Progress Review, CECW-LRD memorandum (2) PCXIN Recommendation (3) PCXIN review manager sign-off sheet. (4) Agency Technical Review certification. and (5) the model documentation package.

4. I concur with the findings of the independent review panel and the recommendations of Mr. Patrick Donovan, Director of the PCXIN and by Mr. Chris Bouquot and Mr. Bob Patev. Based on the totality of the information contained within the package, it is my recommendation that the Cape Cod Canal Bridges Spreadsheet Model for single-use by NAE in the aforementioned study.

RONNY J. SADRI, P.E.
Acting Chief, LRD Planning & Policy
Division and Director, PCX for Inland
Navigation

References:

---

[i] Massachusetts Office of Travel and Tourism, *Economic Impact of Travel on Massachusetts Counties*. Retrieved from https://www.massvacation.com/travel-trade/getting-around/stats-reports/

[ii] Michigan Department of Transportation. *Bridge Structural Elements Diagram.* Retrieved June 10, 2018, from https://www.michigan.gov/mdot/0,4616,7-151-9618_47418-173584--,00.html

[iii] US Army Corps of Engineers. *Engineering Pamphlet EP1130-2-500*. December 27, 1996. F-2

[iv] US Army Corps of Engineers. *Risk Reliability Engineering for Major Rehabilitation Studies. EC1110-2-6062.* February 1, 2011. Chapter 5, 5-2 Consequence Event Trees and I-5. Event Trees 5.7.2015

[v] United States Census Bureau. *American Fact Finder.* Retrieved on August 31, 2018 from https://factfinder.census.gov/faces/nav/jsf/pages/index.xhtml

[vi] US Department of Transportation. *2001 National Household Travel Survey*. Retrieved on January 10, 2018, from https://www.rita.dot.gov/bts/sites/rita.dot.gov.bts/files/publications/highlights_of_the_2001_national_household_travel_survey/html/figure_09.html

[vii] Office of Management and Budget. Fiscal Year 2018 President's Budget. *Economic Assumptions and Interactions with the Budget.* Retrieved on January 11, 2018 from https://www.whitehouse.gov/sites/whitehouse.gov/files/omb/budget/fy2018/ap_2_assumptions.pdf

[viii] Transportation Benefit-Cost Analysis. Retrieved on August 31, 2018, from http://bca.transportationeconomics.org/benefits/vehicle-operating-cost

CAPE COD CANAL HIGHWAY BRIDGES
BOURNE, MASSACHUSETTS

MAJOR REHABILITATION EVALUATION REPORT

APPENDIX E
AGENCY COORDINATION

This Page Intentionally Left Blank

COOPERATING AGENCIES

This Page Intentionally Left Blank

DEPARTMENT OF THE ARMY
US ARMY CORPS OF ENGINEERS
NEW ENGLAND DISTRICT
696 VIRGINIA ROAD
CONCORD MA 01742-2751

November 1, 2018

Programs and Project Management Division
Civil works/IIS Project Management Branch

Mr. Christopher Bisignano
Supervisory Bridge Management Specialist
First Coast Guard District (dpb)
Battery Park Bldg., Room 301
One South Street
New York, New York 10004-1466

Dear Mr. Bisignano:

The U.S. Army Corps of Engineers (USACE), New England District, is undertaking a Major Rehabilitation Evaluation Study for the Bourne and Sagamore bridges, located within the Cape Cod Canal Federal Navigation Project (FNP). The Bourne and Sagamore bridges were constructed from 1933-1935 and require ongoing and increasingly more frequent repairs. The major rehabilitation study will analyze alternatives to either repair or replace the existing deteriorated bridges to restore safe, secure, and cost effective access across the Cape Cod Canal.

As part of the study, we will prepare an Environmental Assessment (EA) pursuant to the National Environmental Policy Act (NEPA) of 1969, as amended. As the lead Federal agency under NEPA, we are inviting your participation as a cooperating agency in the development of the EA.

In accordance with the Council on Environmental Quality (CEQ) final regulations for implementing NEPA (40 C.F.R. § 1501.6 and § 1508.5), the USACE requests your assistance and participation in the NEPA process in the following ways:

a. Attendance at and input during agency coordination meetings, including pre-scoping and scoping;

b. Comment and feedback on the EA schedule, overall scope of the document, issues to be evaluated in the EA, environmental impacts, study and assessment methodologies, range of alternatives and proposed compensatory mitigation, if applicable;

c. Guidance on relevant technical studies required as part of the EA;

d. Identification of issues related to your agency's jurisdiction by law and special expertise;

e. Participation, as appropriate, at public meetings and hearings; and

f. Timely review of the Draft and Final EAs;

Please provide your written acceptance or declination of this invitation and an agency point of contact on or before November 30, 2018.

We anticipate holding a scoping meeting during December of this year. We look forward to working with your agency on the preparation of the EA. If you have any questions or would like to discuss our respective roles and responsibilities during the NEPA process in more detail, please contact either the Project Manager Craig Martin, at 978-318-8638, craig.a.martin@usace.army.mil or Rosemarie Bradley, the Environ. Compliance Lead at 978-318-8127, rosemarie.a.bradley@usace.army.mil.

Sincerely,

Wendy Gendron
Chief, Civil Works/IIS Branch
New England District

Copies Furnished:

Mr. James Rousseau, senior Bridge Mgmt. Specialist
USCG District One
408 Atlantic Avenue
Boston, MA 02110-3350

Mr. Jeffrey Stieb, Bridge Mgmt. Specialist
First Coast Guard District
Boston, MA 02110-3350

U.S. Department of Homeland Security

United States Coast Guard

Commander
First Coast Guard District

One South Street
Battery Park Building
New York, NY 10004-1466
Saff Symbol: dpb
Phone: (212) 514-4331
Fax: (212) 514-4337

16591
November 15, 2018

U.S. Army Corps of Engineers - New England District
Attn: Ms. Wendy Gendron
Chief Civil Works/IIS Branch
696 Virginia Road
Concord, MA 01742-2751

Dear Ms. Gendron:

This is in reply to your letter dated November 1, 2018, concerning a major rehabilitation evaluation study that incorporates the Bourne and Sagamore Bridges at Mile 2.0 and 5.2 respectively, Cape Cod Canal in Barnstable County, Bourne and Sagamore, Massachusetts.

It is our understanding the United States Army Corps of Engineers (USACE) has assumed the role as lead federal agency for the National Environmental Policy Act and other applicable environmental control laws such as the National Historic Preservation Act, Threatened and Endangered Species Act. We agree to serve as a Cooperating Agency for this project and request that the Coast Guard is given the opportunity to review the environmental document before it is finalized.

The General Bridge Act of 1946 requires that the Commandant, U.S. Coast Guard prior to commencing construction, approve the location and plans for bridges over navigable waters of the United States. The Cape Cod Canal is considered a navigable waterway of the United States for bridge administration purposes at the bridge sites.

Applications for bridge permits should be addressed to Commander (dpb), First Coast Guard District, One South Street, Battery Park Building Attention: Bridge Branch. To assist you in submitting a bridge permit application, the Bridge Permit Application Guide can be found at the following link: https://www.dco.uscg.mil/Office-of-Bridge-Programs/ .

The application must be supported by sufficient information to permit a thorough assessment of the impact of the bridge and its immediate approaches on the environment. We recommend that the impacts of procedures for constructing cofferdams, sand islands, and falsework bents, etc., that will be employed to build the bridge or modify the existing bridge as well as the removal of the old bridge be discussed.

We request that you complete Appendix A of the Bridge Permit Application Guide that can be found at the above link in order for the U.S. Coast Guard to analyze the navigational impacts of the bridge design alternatives. Submission of this report is highly encouraged for all applicants to avoid delays and head off potential conflicts in the permit application process.

We appreciate the opportunity to comment on the project in this early stage. You can contact Mr. James Rousseau at (617) 223-8619 or e-mail James.L.Rousseau2@uscg.mil if you have questions regarding our comments or requirements.

Sincerely,

C. J. Bisignano
Supervisory Bridge Management Specialist
U.S. Coast Guard
By direction

E-Copy: USCG SECTOR SENE (Waterways)
Craig Martin, USACE
Rosemarie Bradley, USACE

DEPARTMENT OF THE ARMY
US ARMY CORPS OF ENGINEERS
NEW ENGLAND DISTRICT
696 VIRGINIA ROAD
CONCORD MA 01742-2751

November 1, 2018

Programs and Project Management Division
Civil works/IIS Project Management Branch

Mr. Timothy Timmermann, Director
Office of Environmental Review
EPA New England – region 1
Post Office Square, Suite 100
Mail Code OEP 06-3
Boston, MA 02109-3912

Dear Mr. Timmermann:

The U.S. Army Corps of Engineers (USACE), New England District, is undertaking a Major Rehabilitation Evaluation Study for the Bourne and Sagamore bridges, located within the Cape Cod Canal Federal Navigation Project (FNP). The Bourne and Sagamore bridges were constructed from 1933-1935 and require ongoing and increasingly more frequent repairs. The major rehabilitation study will analyze alternatives to either repair or replace the existing deteriorated bridges to restore safe, secure, and cost effective access across the Cape Cod Canal.

As part of the study, we will prepare an Environmental Assessment (EA) pursuant to the National Environmental Policy Act (NEPA) of 1969, as amended. As the lead Federal agency under NEPA, we are inviting your participation as a cooperating agency in the development of the EA.

In accordance with the Council on Environmental Quality (CEQ) final regulations for implementing NEPA (40 C.F.R. § 1501.6 and § 1508.5), the USACE requests your assistance and participation in the NEPA process in the following ways:

a. Attendance at and input during agency coordination meetings, including pre-scoping and scoping;

b. Comment and feedback on the EA schedule, overall scope of the document, issues to be evaluated in the EA, environmental impacts, study and assessment methodologies, range of alternatives and proposed compensatory mitigation, if applicable;

c. Guidance on relevant technical studies required as part of the EA;

d. Identification of issues related to your agency's jurisdiction by law and special expertise;

e. Participation, as appropriate, at public meetings and hearings; and

f. Timely review of the Draft and Final EAs;

Please provide your written acceptance or declination of this invitation and an agency point of contact on or before November 30, 2018.

We anticipate holding a scoping meeting during December of this year. We look forward to working with your agency on the preparation of the EA. If you have any questions or would like to discuss our respective roles and responsibilities during the NEPA process in more detail, please contact either the Project Manager Craig Martin, at 978-318-8638, craig.a.martin@usace.army.mil or Rosemarie Bradley, the Environ. Compliance Lead at 978-318-8127, rosemarie.a.bradley@usace.army.mil.

Sincerely,

Wendy Gendron
Chief, Civil Works/IIS Branch
New England District

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 1
5 POST OFFICE SQUARE, SUITE 100
BOSTON, MA 02109-3912

November 27, 2018

Wendy Gendron
Chief, Civil Works/IIS Branch
New England District
U.S. Army Corps of Engineers
696 Virginia Road
Concord, MA 01742-2751

RE: Bourne and Sagamore Bridges Major Rehabilitation Study, Cape Cod, Massachusetts

Dear Chief Gendron:

This letter is to accept your invitation to serve as a cooperating agency in support of your work to develop an Environmental Assessment for the Bourne and Sagamore Bridges Major Rehabilitation Study. EPA will serve in that capacity as our schedule and resources allow. Please consider me as the point of contact for coordination purposes.

Thank you for the invitation to be a cooperating agency. Please feel free to contact me at (617) 918-1025 or timmermann.timothy@epa.gov with any questions.

Sincerely,

Timothy L. Timmermann
Director, Office of Environmental Review

Toll Free • 1-888-372-7341
Internet Address (URL) • http://www.epa.gov/region1

Recycled/Recyclable • Printed with Vegetable Oil Based Inks on Recycled Paper (Minimum 30% Postconsumer)

DEPARTMENT OF DEFENSE
UNITED STATES OF AMERICA

DEPARTMENT OF THE ARMY
US ARMY CORPS OF ENGINEERS
NEW ENGLAND DISTRICT
696 VIRGINIA ROAD
CONCORD MA 01742-2751

November 1, 2018

Programs and Project Management Division
Civil works/IIS Project Management Branch

Mr. Michael Pentony, Regional Administrator
NOAA Atlantic Regional Fisheries
Office National Marine Fisheries Service
55 Great Republic Drive
Gloucester, MA 01930

Dear Mr. Pentony:

The U.S. Army Corps of Engineers (USACE), New England District, is undertaking a Major Rehabilitation Evaluation Study for the Bourne and Sagamore bridges, located within the Cape Cod Canal Federal Navigation Project (FNP). The Bourne and Sagamore bridges were constructed from 1933-1935 and require ongoing and increasingly more frequent repairs. The major rehabilitation study will analyze alternatives to either repair or replace the existing deteriorated bridges to restore safe, secure, and cost effective access across the Cape Cod Canal.

As part of the study, we will prepare an Environmental Assessment (EA) pursuant to the National Environmental Policy Act (NEPA) of 1969, as amended. As the lead Federal agency under NEPA, we are inviting your participation as a cooperating agency in the development of the EA.

In accordance with the Council on Environmental Quality (CEQ) final regulations for implementing NEPA (40 C.F.R. § 1501.6 and § 1508.5), the USACE requests your assistance and participation in the NEPA process in the following ways:

a. Attendance at and input during agency coordination meetings, including pre-scoping and scoping;

b. Comment and feedback on the EA schedule, overall scope of the document, issues to be evaluated in the EA, environmental impacts, study and assessment methodologies, range of alternatives and proposed compensatory mitigation, if applicable;

c. Guidance on relevant technical studies required as part of the EA;

d. Identification of issues related to your agency's jurisdiction by law and special expertise;

e. Participation, as appropriate, at public meetings and hearings; and

f. Timely review of the Draft and Final EAs;

Please provide your written acceptance or declination of this invitation and an agency point of contact on or before November 30, 2018.

We anticipate holding a scoping meeting during December of this year. We look forward to working with your agency on the preparation of the EA. If you have any questions or would like to discuss our respective roles and responsibilities during the NEPA process in more detail, please contact either the Project Manager Craig Martin, at 978-318-8638, craig.a.martin@usace.army.mil or Rosemarie Bradley, the Environ. Compliance Lead at 978-318-8127, rosemarie.a.bradley@usace.army.mil.

Sincerely,

Wendy Gendron
Chief, Civil Works/IIS Branch
New England District

Copies Furnished:

Ms. Jennifer Anderson
Acting Chief, Protected Resources Division
NOAA Atlantic Regional Fisheries
Office National Marine Fisheries Service
55 Great Republic Drive
Gloucester, MA 01930

Mr. Lou Chiarella
Chief, Habitat Conservation Division
NOAA Atlantic Regional Fisheries
Office National Marine Fisheries Service
55 Great Republic Drive
Gloucester, MA 01930

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
GREATER ATLANTIC REGIONAL FISHERIES OFFICE
55 Great Republic Drive
Gloucester, MA 01930-2276

AUG 2 2 2019

Wendy Gendron
Chief, Civil Works/IIS Branch
Department of the Army, Corps of Engineers
New England District
696 Virginia Road
Concord, MA 01742-2751

Re: Major Rehabilitation Evaluation Study for the Bourne and Sagamore Bridges, Request for Participation as a Cooperating Agency

Dear Ms. Gendron:

Thank you for your letter, dated November 1, 2018, requesting that we participate as a cooperating agency in the preparation of an Environmental Assessment (EA) associated with the Major Rehabilitation Evaluation Study for the Bourne and Sagamore Bridges located within the Cape Cod Canal Federal Navigation Project (FNP). We agree to participate as a cooperating agency to help advance effective interagency coordination on this project.

Our role and degree of involvement as a cooperating agency is dependent on existing staff and fiscal resources. Our contributions will be limited to providing written comments in response to your documents prepared as part of the National Environmental Policy Act (NEPA) process. You can expect our comments in response to provide technical information identifying species and habitats of concern, identification of issues and topics that need consideration and evaluation in your NEPA process, and guidance on evaluating, minimizing and avoiding effects to our trust resources. We are not in a position to undertake data collection, conduct analyses, or prepare sections of the NEPA documents as staff and resources are fully tasked in other obligatory National Marine Fisheries Service (NMFS) programs.

Please note that our involvement as a cooperating agency does not constitute an endorsement of this project, nor does it obviate the need for consultations required under the Magnuson-Stevens Fishery Conservation and Management Act, Fish and Wildlife Coordination Act, and the Endangered Species Act (ESA).

Thank you for the opportunity to participate as a cooperating agency on this project. We look forward to working with you. If you have any questions regarding this matter, please contact Alison Verkade at (978) 281-9266 or by email at Alison.Verkade@noaa.gov for information regarding Essential Fish Habitat or other trust resources, or Zach Jylkka at (978) 282-8467 or by email at Zachary.Jylkka@noaa.gov for information regarding threatened and endangered species listed by us under the ESA.

Sincerely,

Jennifer Anderson
Acting Assistant Regional Administrator
for Protected Resources

EC: Verkade, NMFS HCD; Bradley, Martin, Randall, USACE
File Code: H:\Section 7 Team\Section 7\Non-Fisheries\ACOE\Informal\2019\New England\Cape Cod Canal Bridge Replacement\Pre-Consultation

DEPARTMENT OF DEFENSE
UNITED STATES OF AMERICA

DEPARTMENT OF THE ARMY
US ARMY CORPS OF ENGINEERS
NEW ENGLAND DISTRICT
696 VIRGINIA ROAD
CONCORD MA 01742-2751

November 1, 2018

Programs and Project Management Division
Civil works/IIS Project Management Branch

Ms. Stephanie Pollack
MA Department of Transportation
Ten Park Plaza, Suite 4160
Boston, MA 02116

Dear Ms. Pollack:

The U.S. Army Corps of Engineers (USACE), New England District, is undertaking a Major Rehabilitation Evaluation Study for the Bourne and Sagamore bridges, located within the Cape Cod Canal Federal Navigation Project (FNP). The Bourne and Sagamore bridges were constructed from 1933-1935 and require ongoing and increasingly more frequent repairs. The major rehabilitation study will analyze alternatives to either repair or replace the existing deteriorated bridges to restore safe, secure, and cost effective access across the Cape Cod Canal.

As part of the study, we will prepare an Environmental Assessment (EA) pursuant to the National Environmental Policy Act (NEPA) of 1969, as amended. As the lead Federal agency under NEPA, we are inviting your participation as a cooperating agency in the development of the EA.

In accordance with the Council on Environmental Quality (CEQ) final regulations for implementing NEPA (40 C.F.R. § 1501.6 and § 1508.5), the USACE requests your assistance and participation in the NEPA process in the following ways:

a. Attendance at and input during agency coordination meetings, including pre-scoping and scoping;

b. Comment and feedback on the EA schedule, overall scope of the document, issues to be evaluated in the EA, environmental impacts, study and assessment methodologies, range of alternatives and proposed compensatory mitigation, if applicable;

c. Guidance on relevant technical studies required as part of the EA;

d. Identification of issues related to your agency's jurisdiction by law and special expertise;

e. Participation, as appropriate, at public meetings and hearings; and

f. Timely review of the Draft and Final EAs;

Please provide your written acceptance or declination of this invitation and an agency point of contact on or before November 30, 2018.

We anticipate holding a scoping meeting during December of this year. We look forward to working with your agency on the preparation of the EA. If you have any questions or would like to discuss our respective roles and responsibilities during the NEPA process in more detail, please contact either the Project Manager Craig Martin, at 978-318-8638, craig.a.martin@usace.army.mil or Rosemarie Bradley, the Environ. Compliance Lead at 978-318-8127, rosemarie.a.bradley@usace.army.mil.

Sincerely,

Wendy Gendron
Chief, Civil Works/IIS Branch
New England District

Charles D. Baker, Governor
Karyn E. Polito, Lieutenant Governor
Stephanie Pollack, MassDOT Secretary & CEO

massDOT
Massachusetts Department of Transportation

August 27, 2019

Ms. Wendy Gendron
Chief, Civil Works/IIS Branch
US Army Corps of Engineers
New England District
696 Virginia Road
Concord, MA 01742-2751

Re: Major Rehabilitation Study
NEPA Environmental Assessment
Cooperating Agency

Dear Ms. Gendron:

Thank you for your letter regarding MassDOT participation as a cooperating agency in the development of the National Environmental Policy Act (NEPA) Environmental Assessment (EA) included in the Major Rehabilitation Evaluation Report (MRER) for the Bourne and Sagamore bridges, located within the Cape Cod Canal Federal Navigation Project (FNP).

MassDOT accepts the US Army Corps of Engineers invitation to participate as a cooperating agency in development of the EA in accordance with the Council on Environmental Quality (CEQ) final regulations for implementing NEPA (40 C.F.R. 1501.6 and 1508.5), as outlined in your November1st, 2018 letter.

Your MassDOT agency point of contact for development of the EA is James Cerbone, at 857-368-8792, or james.cerbone@state.ma.us. We look forward to our future collaboration on this regionally significant project.

If you have any additional questions regarding this matter, please do not hesitate to contact me again.

Sincerely,

Stephanie Pollack
Secretary and CEO

Ten Park Plaza, Suite 4160, Boston, MA 02116
Tel: 857-368-4636, TTY: 857-368-0655
www.mass.gov/massdot

DEPARTMENT OF THE **ARMY**
US ARMY CORPS OF ENGINEERS
NEW ENGLAND DISTRICT
696 VIRGINIA ROAD
CONCORD MA 01742-2751

November 1, 2018

Programs and Project Management Division
Civil works/IIS Project Management Branch

Mr. Jeff McEwen, Regional Administrator
US Department of Transportation
Federal Highway Administration
55 Broadway, 10th Floor
Cambridge, MA 02142

Dear Mr. McEwen:

The U.S. Army Corps of Engineers (USAGE), New England District, is undertaking a Major Rehabilitation Evaluation Study for the Bourne and Sagamore bridges, located within the Cape Cod Canal Federal Navigation Project (FNP). The Bourne and Sagamore bridges yvere constructed from 1933-1935 and require ongoing and increasingly more frequent repairs. The major rehabilitation study will analyze alternatives to either repair or replace the existing deteriorated bridges to restore safe, secure, and cost effective access across the Cape Cod Canal.

As part of the study, we will prepare an Environmental Assessment (EA) pursuant to the National Environmental Policy Act (NEPA) of 1969, as amended. As the lead Federal agency under NEPA, we are inviting your participation as a cooperating agency in the development of the EA.

In accordance with the Council on Environmental Quality (CEO) final regulations for implementing NEPA (40 C.F.R. § 1501.6 and§ 1508.5), the USAGE requests your assistance and participation in the NEPA process in the following ways:

a. Attendance at and input during agency coordination meetings, including pre-scoping and scoping;

b. Comment and feedback on the EA schedule, overall scope of the document, issues to be evaluated in the EA, environmental impacts, study and assessment methodologies, range of alternatives and proposed compensatory mitigation, if applicable;

c. Guidance on relevant technical studies required as part of the EA;

d. Identification of issues related to your agency's jurisdiction by law and special expertise;

e. Participation, as appropriate, at public meetings and hearings; and

f. Timely review of the Draft and Final EAs;

Please provide your written acceptance or declination of this invitation and an agency point of contact on or before November 30, 2018.

We anticipate holding a scoping meeting during December of this year. We look forward to working with your agency on the preparation of the EA. If you have any questions or would like to discuss our respective roles and responsibilities during the NEPA process in more detail, please contact either the Project Manager Craig Martin, at 978-318-8638, craig.a.martin@usace.army.mil or Rosemarie Bradley, the Environ. Compliance Lead at 978-318-8127, rosemarie.a.bradley@usacearmy.mil.

Sincerely,

Wendy Gendron
Chief, Civil Works/IIS Branch
New England District

U.S. Department
of Transportation
**Federal Highway
Administration**

Massachusetts Division

55 Broadway, 10th Floor
Cambridge, MA 02142
(617) 494-3657 (phone)
(617) 494-3355 (fax)
www.fhwa.dot.gov/madiv

November 28, 2018

In Reply Refer To:
HDA-MA

Wendy Gendron
Department of the Army
U.S. Army Corps of Engineers
New England District
696 Virginia Road
Concord, MA 01742

***Subject: Cooperating Agency Invitation, NEPA, Bourne and Sagamore Bridges,
Cape Cod Canal***

Dear Ms. Gendron:

Thank you for your letter dated November 1, 2018 inviting the Federal Highway Administation (FHWA) to be a cooperating agency in the preparation of the Environmental Assessment pursuant to National Environmental Policy Act (NEPA) for the U.S. Army Corps of Engineers Major Rehabiliation Study for the Bourne and Sagamore Bridges over the Cape Cod Canal. We understand that the major rehabilitation study will analyze alternatives to either repair or replace the existing bridges to restore safe, secure, and cost effective access over Cape Cod Canal.

We accept the invitation to assistance and participate in the NEPA process consistent with the six ways listed in your letter. The FHWA point of contact for this process is,

Ms. Cassandra "Cassie" Ostrander
Environmental Protection Specialist
Federal Highway Administation
Massachusetts Division
55 Broadway, 10th Floor
Cambridge, MA 02142
(617) 494-3113
cassandra.ostrander@dot.gov

If you have any questions or comments, please contact me at or Cassie Chase Ostrander at (617) 494-3113.

Sincerely,

Jeffrey H. McEwen, PE
Division Administrator

Sincerely,

Jennifer Anderson
Acting Assistant Regional Administrator
for Protected Resources

EC: Verkade, NMFS HCD; Bradley, Martin, Randall, USACE
File Code: H:\Section 7 Team\Section 7\Non-Fisheries\ACOE\Informal\2019\New England\Cape Cod Canal Bridge Replacement\Pre-Consultation

U.S. Department
of Transportation
**Federal Highway
Administration**

Massachusetts Division

55 Broadway, 10th Floor
Cambridge, MA 02142
(617) 494-3657 (phone)
(617) 494-3355 (fax)
www.fhwa.dot.gov/madiv

November 28, 2018

In Reply Refer To:
HDA-MA

Wendy Gendron
Department of the Army
U.S. Army Corps of Engineers
New England District
696 Virginia Road
Concord, MA 01742

***Subject: Cooperating Agency Invitation, NEPA, Bourne and Sagamore Bridges,
Cape Cod Canal***

Dear Ms. Gendron:

Thank you for your letter dated November 1, 2018 inviting the Federal Highway Administation (FHWA) to be a cooperating agency in the preparation of the Environmental Assessment pursuant to National Environmental Policy Act (NEPA) for the U.S. Army Corps of Engineers Major Rehabiliation Study for the Bourne and Sagamore Bridges over the Cape Cod Canal. We understand that the major rehabilitation study will analyze alternatives to either repair or replace the existing bridges to restore safe, secure, and cost effective access over Cape Cod Canal.

We accept the invitation to assistance and participate in the NEPA process consistent with the six ways listed in your letter. The FHWA point of contact for this process is,

Ms. Cassandra "Cassie" Ostrander
Environmental Protection Specialist
Federal Highway Administation
Massachusetts Division
55 Broadway, 10th Floor
Cambridge, MA 02142
(617) 494-3113
cassandra.ostrander@dot.gov

If you have any questions or comments, please contact me at or Cassie Chase Ostrander at (617) 494-3113.

Sincerely,

Jeffrey H. McEwen, PE
Division Administrator

This Page Intentionally Left Blank

AGENCY SCOPING AND COORDINATED SITE VISIT

This Page Intentionally Left Blank

Agency Scoping and Coordinating Site Visit

Contact	**Title**	**Address**
James Rousseau	Senior Bridge Mgt Specialist	USCG District 1 408 Atlantic Ave. Boston, MA 02110-3350
Jeffrey Stieb	Bridge Mgt Specialist	USCG District 1 408 Atlantic Ave. Boston, MA 02110-3350
Timothy L. Timmermann	Director	Office of Environmental Review EPA New England - Region 1 5 Post Office Square Suite 100 Mail Code OEP 06-3 Boston, MA 02109-3912
Ms. Regina Lyons	Ocean & Coastal Protection Unit Manager	Office of Environmental Review EPA New England - Region 1 5 Post Office Square, Suite 100 Mail Code OEP 06-3, Boston, MA 02109-3912
Tom Chapman	Supervisor	U.S. Fish and Wildlife Service New England Field Office 70 Commercial Street, Suite 300 Concord, NH 03301-5087
Susi von Oettingen	Biologist	U.S. Fish and Wildlife Service New England Field Office 70 Commercial Street, Suite 300 Concord, NH 03301-5087
Michael Pentony	Regional Administrator	NOAA Atlantic Regional Fisheries Office National Marine Fisheries Service 55 Great Republic Drive Gloucester, MA 01930
Jennifer Anderson	Acting Chief, Protected Resources Div	NOAA Atlantic Regional Fisheries Office National Marine Fisheries Service 55 Great Republic Drive Gloucester, MA 01930
Lou Chiarella	Chief, Habitat Conservation Div	NOAA Atlantic Regional Fisheries Office National Marine Fisheries Service 55 Great Republic Drive Gloucester, MA 01930

Alizon Verkade	Office Habitat Conservation Div	NOAA Atlantic Regional Fisheries Office National Marine Fisheries Service 55 Great Republic Drive Gloucester, MA 01930
Zach Jylkka	Fisheries Biologist, Protected Resources Division	NOAA Atlantic Regional Fisheries Office National Marine Fisheries Service 55 Great Republic Drive Gloucester, MA 01930
Nelson Hoffman	Transportation Performance Management Program Manager	FHWA 1200 New Jersey Avenue, SE Washington, DC 20590
Christopher Hansen	Env. Prot. Spec	FHWA Eastern Federal Lands Highway Division 21400 Ridgetop Circle Sterling, VA 20166
Cassie Ostrander	Env Prot Spec	FHWA 55 Broadway 10th Floor Cambridge, Massachusetts 02142
Ms. Ramona Peters	Tribal Historic Preservation Officer	Mashpee Wampanoag Tribe 483 Great Neck Road Mashpee, MA 02649-3707
David Weeden	Tribal Historic Preservation Officer	Mashpee Wampanoag Tribe 483 Great Neck Rd. Mashpee, MA 02649
Ms. Bettina M. Washington	Tribal Historic Preservation Officer (THPO)	Wampanoag Tribe of Gay Head (Aquinnah) 20 Black Brook Road Aquinnah, MA 02535-1546
Jim Cerbone	Environmental	Massachusetts Department of Transportation Ten Park Plaza Suite 4160 Boston, MA 02116
James Harwood	Cultural Resources	Massachusetts Department of Transportation Ten Park Plaza Suite 4160 Boston, MA 02116
John Bechard	Dept. Chief Engineer	Massachusetts Department of Transportation Ten Park Plaza Suite 4160 Boston, MA 02116
Ms. Brona Simon	Executive Director	MA Historical Commission 220 Morrissey Boulevard Boston, Massachusetts 02125-3314

Tom French	Assistant Director Regulatory Review Program	MA Div of Fisheries and Wildlife Natural Heritage and Endangered Species Program 1 Rabbit Hill Road Westborough, MA 01581-3336
Ronald Amidon	Commissioner	MA Department of Fish and Game 251 Causeway St, Suite 400 Boston, MA 02114-2152
Kathryn Ford, Ph.D.	Habitat Program Manager	MA Department of Fish and Game 251 Causeway St, Suite 400 Boston, MA 02114-2152
John Logan, Ph.D.	Env. Review – Cohasset and South	MA Division of Marine Fisheries 836 South Rodney French Blvd. New Bedford, MA 02744
Lealdon Langley	Director, Wetlands and Waterways Division	MA DEP Wetlands & Waterways One Winter St. Boston, MA 02108
Ms. Millie Garcia-Serano	SE Regional Director	MA DEP Southeast Regional Office 20 Riverside Dr. Lakeville, MA 02347
Mr. Robert Boeri	Project Review Coordinator	Massachusetts Office of Coastal Zone Management 251 Causeway Street, Suite 800 Boston, MA 02114-2138
Lisa Berry Engler	Acting Director	Massachusetts Office of Coastal Zone Management 251 Causeway Street, Suite 800 Boston, MA 02114-2138
Stephen McKenna	Cape Cod & Islands Regional Coordinator	Massachusetts Office of Coastal Zone Management Cape Cod and Islands Regional Office 3195 Main Street P.O. Box 220 Barnstable, MA 02360
Paul E. Rendon		Building 3468, Beaman St. Buzzards Bay, MA 02542
Michael Ciaranca		MA Air National Guard Building 3468 Camp Edwards, MA 02542
David DeConto		Sandwich Conservation Commission 16 Jan Sebastian Dr.

		Sandwich, MA 02563
Mr. David Schrader		Sandwich Historic Commission 1 6 Jan Sebastian Dr. Sandwich, MA 02563
Robert Gray	Chairman	Bourne Conservation Commission 24 Perry Ave. Bourne, MA 02532
David S. Robinson	Chief Archaeologist, State Underwater Archaeologist	Massachusetts Board of Underwater Archaeological Resources 251 Causeway Street, Suite 800 Boston, MA 02114-2199

DEPARTMENT OF THE ARMY
US ARMY CORPS OF ENGINEERS
NEW ENGLAND DISTRICT
696 VIRGINIA ROAD
CONCORD MA 01742-2751

March 7, 2019

Programs and Project Management Division
Civil Works/IIS Project Management Branch
Navigation Section

SAMPLE

Ms. Jennifer Anderson, Acting Chief, Protection Resources Division
NOAA Atlantic Regional Fisheries Office
National Marine Fisheries Service
55 Great Republic Drive
Gloucester, Massachusetts 01930

Dear Ms. Anderson:

The U.S. Army Corps of Engineers (Corps), New England District, is conducting a multi-year Major Rehabilitation Evaluation Study of the Bourne and Sagamore highway bridges spanning the Cape Cod Canal. The study will result in a Major Rehabilitation Evaluation Report (MRER). The MRER will provide the basis of decision making for USACE and Congress to determine the most cost-effective, safe alternative for critical public transportation access across the Cape Cod Canal.

As part of the MRER, the Corps will be preparing an Environmental Assessment (EA) to analyze the potential environmental effects associated with the project. The major rehabilitation study will analyze alternatives to either repair or replace the existing deteriorated Bourne and Sagamore Bridges.

The purpose of this letter is to begin coordination pursuant to the Fish and Wildlife Coordination Act, as amended and Section 7(c) of the Endangered Species Act of 1973, as amended, and to invite you, or a member of your staff, to attend an agency scoping meeting and coordinated site visit with interested State and Federal agencies, Federally-recognized tribes, and town officials. The objective of this meeting is to explain the proposed project and to elicit agency concerns and suggestions. The meeting and site visit will occur on Tuesday, March 19, 2019. During the meeting, participants will have the opportunity to discuss alternatives, visit the study area, and provide feedback and suggestions to the USACE study team. We will meet at 1 p.m. at the Massachusetts Maritime Academy's Bay State conference room located at 101 Academy Drive, Buzzards Bay, MA 02532. A campus map with meeting room location highlighted is enclosed. After a short presentation and discussion of the project vans will take participants to viewing locations at the base of the Bourne and Sagamore bridges. Participants will be returned to the academy upon completion of the site visit no later than 3pm.

We are requesting written preliminary comments on the proposed project (which will be described in greater detail during the site visit) from your agency within 30 days of the meeting. Comments should include any concerns that need to be addressed during the planning phase of the proposed project. Comments in support of the project as presented are also requested.

We look forward to your participation in this project. If you have any questions or require additional information, please contact Rosemarie Bradley, Environmental Compliance Lead at 978-318-8127 or by e-mail at rosemarie.a.bradley@usace.army.mil. Please RSVP by Friday, March15 via email to Craig Martin at craig.a.martin@usace.army.mil so we can confirm the appropriate number of vans for the bridge site visit portion of the meeting.

Sincerely,

Craig Martin
Project Manager
New England District

Enclosure

SAMPLE

ATTENDANCE SHEETS

U.S. Army Corps of Engineers, New England District
Attendance sheets for the Cape Cod Canal Bridges Agency Meeting
March 19, 2019

Name: Timothy Timmerman

Address: EPA Region 1

Telephone: 617-918-1025

Agency, Business or Organization(s) (if any): EPA

Name: Samuel Haines

Address: 24 Perry Ave

Telephone: 508 326 2765 shaines@townofbourne.com

Agency, Business or Organization(s) (if any): Bourne Conservation Dep

---

Name: Bettina M Washington - THPO

Address: 20 Black Brook Rd
Aquinnah MA 02535

Telephone: 508-645-9265

Agency, Business or Organization(s) (if any): WTGH(A)

U.S. Army Corps of Engineers, New England District
Attendance sheets for the Cape Cod Canal Bridges Agency Meeting
March 19, 2019

Name: James Rousseau

Address:

Telephone: 617-223-8619

Agency, Business or Organization(s) (if any): USCG D1 Bridges

---

Name: Jameson Harwood

Address: Mass DOT - 10 Park Plaza

Telephone: 857-368-8799

Agency, Business or Organization(s) (if any): MassDOT Cultural Resources

---

Name: Bob Boeri

Address: CZM 251 Causeway St
Boston MA

Telephone: 617-626-1050

Agency, Business or Organization(s) (if any): CZM

U.S. Army Corps of Engineers, New England District
Attendance sheets for the Cape Cod Canal Bridges Agency Meeting
March 19, 2019

Name: Jim Cerbone

Address: 16 Park Plaza, Boston

Telephone: 857-368-8792

Agency, Business or Organization(s) (if any):
Mass DOT

Name: Jeffrey Stieb

Address: US Coast Guard 408 Atlantic Av
Boston, MA 02110

Telephone: 781-901-0348

Agency, Business or Organization(s) (if any):

Name: Stephen McKenna

Address: CZM
P.O. Box 220, Barnstable

Telephone:

Agency, Business or Organization(s) (if any):

U.S. Army Corps of Engineers, New England District
Attendance sheets for the Cape Cod Canal Bridges Agency Meeting
March 19, 2019

Name: Cassie Ostrander

Address: 55 Broadway, 10th Flr.
Cambridge, MA

Telephone: 617-494-3113

Agency, Business or Organization(s) (if any): FHWA- MA Division

---

Name: PAUL E. RENDON

Address: BUILDING 3468, BEAMAN ST, BUZZARDS BAY 02542

Telephone: 774-327-0643

Agency, Business or Organization(s) (if any): JOINT BASE CAPE COD

Name:

Address:

Telephone:

Agency, Business or Organization(s) (if any):

U.S. Army Corps of Engineers, New England District
Attendance sheets for the Cape Cod Canal Bridges Agency Meeting
March 19, 2019

Name: Michael Ciaranca

Address: Bldg 3468, Camp Edwards, MA
02542

Telephone: 508-~~2~~968-5154

Agency, Business or Organization(s) (if any): MA ARNG

Name: David Weeden

Address: 483 Great Neck Rd. South
Mashpee, MA 02649

Telephone: (508) 477-0208 x102

Agency, Business or Organization(s) (if any): Mashpee Wampanoag Tribe-THPO

Name:

Address:

Telephone:

Agency, Business or Organization(s) (if any):

RESOURCE AGENCY COORDINATION

This Page Intentionally Left Blank

From: Bradley, Rosemarie A CIV USARMY CENAE (US)
To: Decelles, Elizabeth C CIV USARMY CENAE (US)
Subject: FW: [Non-DoD Source] Re: Cape Cod Canal Bridges Agency Phone Meeting Record
Date: Wednesday, August 7, 2019 7:49:27 AM

-----Original Message-----
From: Zachary Jylkka - NOAA Federal [mailto:zachary.jylkka@noaa.gov]
Sent: Thursday, July 25, 2019 9:42 AM
To: Bradley, Rosemarie A CIV USARMY CENAE (US) <Rosemarie.A.Bradley@usace.army.mil>
Subject: [Non-DoD Source] Re: Cape Cod Canal Bridges Agency Phone Meeting Record

Hi Rosemarie,

This looks good to me. Thank you for giving me an opportunity to review.

Regards,
Zach

On Tue, Jul 16, 2019 at 5:10 PM Bradley, Rosemarie A CIV USARMY CENAE (US) <Rosemarie.A.Bradley@usace.army.mil <mailto:Rosemarie.A.Bradley@usace.army.mil> > wrote:

> Hi Zach,
> We are following up to ensure we have captured our phone meeting details accurately - Please see attached.
> Thanks,
> Rosemarie
>
> -----------------------
> Rosemarie Bradley, Ph.D.
> Marine Biologist
> US Army Corps of Engineers
> New England District
> 696 Virginia Road
> Concord, MA 01742
> 978-318-8127
> rosemarie.a.bradley@usace.army.mil <mailto:rosemarie.a.bradley@usace.army.mil>

--

Zach Jylkka
Fisheries Biologist

Protected Resources Division
Greater Atlantic Regional Fisheries Office NOAA Fisheries Gloucester, MA 01930 zachary.jylkka@noaa.gov <mailto:zachary.jylkka@noaa.gov>

office: (978) 282-8467

Pronouns: (he/him/his)

For additional ESA Section 7 information and Critical Habitat guidance, please see:
Blockedwww.greateratlantic.fisheries.noaa.gov/protected/section7
<Blockedhttp://www.greateratlantic.fisheries.noaa.gov/protected/section7>

Meeting Record

Subject: Cape Cod Canal (CCC) Bridges MRER, EA and NOAA ESA and EFH Coordination
Attendees: Zach Jylkka, Fisheries Biologist, Protected Resources Division, GARFO, NOAA; Craig Martin, USACE Project Manager, David Oster, USACE Biologist, Rosemarie Bradley, USACE Marine Biologist
Date: Monday, May 20, 2019

Summary

- Phase I of the CCC Bridges project is the Major Rehabilitation Evaluation Report (MRER) decision document and accompanying EA for this phase of the project
- Phase II of the Bridges project will be the design and construction phase and a supplemental EA will be prepared for this phase as well
- It is too early in the project development stage to enter into consultation. NOAA would like us to wait until we are further along in the process before we initiate consultation. They cannot provide specific comments for this phase of the project
- We can determine "areas of potential impacts" and species to be considered including:
    - Atlantic Sturgeon
    - Short nose Sturgeon
    - 4 species of sea turtles including Kemps Ridley and Loggerhead who are susceptible to "cold-stunning"
    - North Atlantic Right Whale – biggest concern
    - Fin Whale
- Sturgeon have the potential to transit through the canal, but none have been documented in the Canal in the past
- Sea turtles are not expected to be present in the canal. They typically migrate May – end of October
- Corps needs to consider Kemps Ridley and Loggerhead during cold stunning season – Mid/late October – December; sometimes they get caught in Cape Cod Bay
- Right whales on occasion transit through the canal, and are the biggest concern, so we need to address in-water work.
    - How will the bridges be demolished? If blasting will occur to remove old bride piers, we need to look at potential impacts.
    - Will barges be used to install new bridges? If so, need a plan if right whales enter canal while barges are there
    - Existing plan - shut down the canal and escort the whale through
    - Any interaction with a right whale – need to address how to avoid "harassment" – identify measures
    - Look at the "Test Tidal Turbine" for sample language and mitigation measures
    - Look at time of year restrictions – January-May in cape Cod Bay
- Identify general types of in-water stressors and plan to consider these – vehicle traffic, noise, turbidity etc.
- NOAA can't make effects determination at this time
- Zach will look at what we draft for Phase I of the project and accompanying EA and will fill in Alison. We will follow-up with Alison after Zach speaks with her

From: vonOettingen, Susi
To: Bradley, Rosemarie A CIV USARMY CENAE (US)
Cc: Eliese Dykstra
Subject: [Non-DoD Source] Re: [EXTERNAL] Cape Cod Canal Highway Bridges Major Rehab Evaluation Report (MRER) Call
Date: Monday, April 1, 2019 7:20:09 AM

Hi Rosemarie,

Thank you for a great summary of our discussion. Yes, I think you covered all of the pertinent points.

Susi

****
Susi von Oettingen
Endangered Species Biologist
New England Field Office
70 Commercial Street, Suite 300
Concord, NH 03301
(W) 603-227-6418
(Fax) 603-223-0104

Blockedwww.fws.gov/newengland <Blockedhttp://www.fws.gov/newengland>

On Tue, Mar 26, 2019 at 4:04 PM Bradley, Rosemarie A CIV USARMY CENAE (US) <Rosemarie.A.Bradley@usace.army.mil <mailto:Rosemarie.A.Bradley@usace.army.mil> > wrote:

> Hi Susi,
> I wanted to make sure I accurately captured our recent phone conversation.
>
> To summarize:
> *This phase of the project ("Phase I") is solely a decision document to determine whether major rehabilitation or replacement of the Bourne and Sagamore bridges is the recommended path forward
> *As there is no concrete project yet , there are no impacts to species for this phase (Phase I)
> *We will inventory what species are present and those that utilize the canal
> *We should include migratory birds and transient birds - Plovers, Red knot and Roseate terns
> *Roseate terns are known to use the canal as a flyway
> *No need to consider American chaffseed or Northern red-bellied cooter
> *Bats are known to roost in bridges. FWS recommends a "bridge survey" when we move on to the design and construction phase
> *In future phases we will need to consider staging areas, tree clearing, and potential time of year restrictions
> *FWS has numerous radio-tracked bird reports and data if needed
>
> Is there anything I have missed?
> Rosemarie
>
> -----------------------
> Rosemarie Bradley, Ph.D.

Marine Biologist
US Army Corps of Engineers
New England District
696 Virginia Road
Concord, MA 01742
978-318-8127
rosemarie.a.bradley@usace.army.mil <mailto:rosemarie.a.bradley@usace.army.mil>

This Page Intentionally Left Blank

STATE AND TRIBAL HISTORIC PRESERVATION OFFICE COORDINATION

This Page Intentionally Left Blank

RECEIVED
JUL 24 2019
MASS. HIST. COMM
RC.66038

DEPARTMENT OF THE ARMY
US ARMY CORPS OF ENGINEERS
NEW ENGLAND DISTRICT
696 VIRGINIA ROAD
CONCORD MA 01742-2751

July 17, 2019

Planning Division
Evaluation Branch

Ms. Brona Simon, State Historic Preservation Officer
Massachusetts Historic Commission
220 Morrissey Boulevard
Boston, MA 02125

CONCURRENCE.
8/22/19
BRONA SIMON
STATE HISTORIC
PRESERVATION OFFICER
MASSACHUSETTS
HISTORICAL COMMISSION

Dear Ms. Simon:

The U.S. Army Corps of Engineers (Corps), New England District, is preparing a multi-year Major Rehabilitation Evaluation Study of the Bourne and Sagamore highway bridges spanning the Cape Cod Canal. The study will result in a Major Rehabilitation Evaluation Report (MRER). The MRER will provide the basis of decision making for the Corps and Congress to determine the most cost-effective, safe alternative for critical public transportation access across the Cape Cod Canal.

As part of the MRER, the Corps is preparing an Environmental Assessment (EA) to analyze the potential environmental effects associated with the project. The major rehabilitation study will analyze alternatives to either repair or replace the existing deteriorated Bourne and Sagamore Bridges. The National Environmental Policy Act (NEPA) survey areas are shown in the attached figure.

Currently, the Corps believes that the rehabilitation of the Bourne and Sagamore bridges should have no adverse effect to the bridges and no effect on local historic districts, individual buildings or known and unknown archaeological sites. The major rehabilitation will include replacement of the bridge superstructure, deck replacement, including stringer replacement, abutment span replacement, exterior gusset plate retrofits, interior gusset plate repairs, miscellaneous concrete repairs, suspender cable replacement, paving, and painting. The bridges would continue in their current footprints, and while changes would be made to the bridges, they will look the same after rehabilitation as materials will be replaced in-kind. This effects determination is contingent on the use of previously disturbed laydown and staging areas. If new areas are chosen, an intensive archaeological survey may be required.

During this phase, based on the research completed to date, the replacement of the Bourne and Sagamore Bridges would have an adverse effect on the bridges and at least two identified archaeological sites, possible unidentified archaeological resources,

and several historic districts. The effects would be indirect (visual and/or viewshed) as well as direct (possible archaeological sites).

The MRER decision document and accompanying NEPA document constitutes the initial phase of the major rehabilitation study. Based on the outcome of this study and once an alternative to either repair or replace the existing bridges has been identified, additional analysis will be completed that will allow for more detailed review of project related impacts. Additional coordination will take place with SHPO at that time.

We are requesting your comments on our preliminary determinations of effect. If you have any questions or comments, please contact Kate Atwood, staff archaeologist at (978)318-8537 or via email at Kathleen.a.atwood@usace.army.mil.

Sincerely,

Joseph B. Mackay
Acting Chief, Evaluation Branch

Enclosure

Similar letters sent to:

Ms. Bettina Washington, Tribal Historic Preservation Officer
Wampanoag Tribe of Gay Head (Aquinnah)
20 Black Brook Road
Aquinnah, MA 02535

Mr. David Weeden, Tribal Historic Preservation Officer
Mashpee Wampanoag Tribe
483 Great Neck Road South
Mashpee, MA 02649

DEPARTMENT OF THE ARMY
US ARMY CORPS OF ENGINEERS
NEW ENGLAND DISTRICT
696 VIRGINIA ROAD
CONCORD MA 01742-2751

July 17, 2019

Planning Division
Evaluation Branch

Ms. Brona Simon, State Historic Preservation Officer
Massachusetts Historic Commission
220 Morrissey Boulevard
Boston, MA 02125

Dear Ms. Simon:

The U.S. Army Corps of Engineers (Corps), New England District, is preparing a multi-year Major Rehabilitation Evaluation Study of the Bourne and Sagamore highway bridges spanning the Cape Cod Canal. The study will result in a Major Rehabilitation Evaluation Report (MRER). The MRER will provide the basis of decision making for the Corps and Congress to determine the most cost-effective, safe alternative for critical public transportation access across the Cape Cod Canal.

As part of the MRER, the Corps is preparing an Environmental Assessment (EA) to analyze the potential environmental effects associated with the project. The major rehabilitation study will analyze alternatives to either repair or replace the existing deteriorated Bourne and Sagamore Bridges. The National Environmental Policy Act (NEPA) survey areas are shown in the attached figure.

Currently, the Corps believes that the rehabilitation of the Bourne and Sagamore bridges should have no adverse effect to the bridges and no effect on local historic districts, individual buildings or known and unknown archaeological sites. The major rehabilitation will include replacement of the bridge superstructure, deck replacement, including stringer replacement, abutment span replacement, exterior gusset plate retrofits, interior gusset plate repairs, miscellaneous concrete repairs, suspender cable replacement, paving, and painting. The bridges would continue in their current footprints, and while changes would be made to the bridges, they will look the same after rehabilitation as materials will be replaced in-kind. This effects determination is contingent on the use of previously disturbed laydown and staging areas. If new areas are chosen, an intensive archaeological survey may be required.

During this phase, based on the research completed to date, the replacement of the Bourne and Sagamore Bridges would have an adverse effect on the bridges and at least two identified archaeological sites, possible unidentified archaeological resources,

and several historic districts. The effects would be indirect (visual and/or viewshed) as well as direct (possible archaeological sites).

The MRER decision document and accompanying NEPA document constitutes the initial phase of the major rehabilitation study. Based on the outcome of this study and once an alternative to either repair or replace the existing bridges has been identified, additional analysis will be completed that will allow for more detailed review of project related impacts. Additional coordination will take place with SHPO at that time.

We are requesting your comments on our preliminary determinations of effect. If you have any questions or comments, please contact Kate Atwood, staff archaeologist at (978)318-8537 or via email at Kathleen.a.atwood@usace.army.mil.

Sincerely,

Joseph Mackay

Joseph B. Mackay
Acting Chief, Evaluation Branch

Enclosure

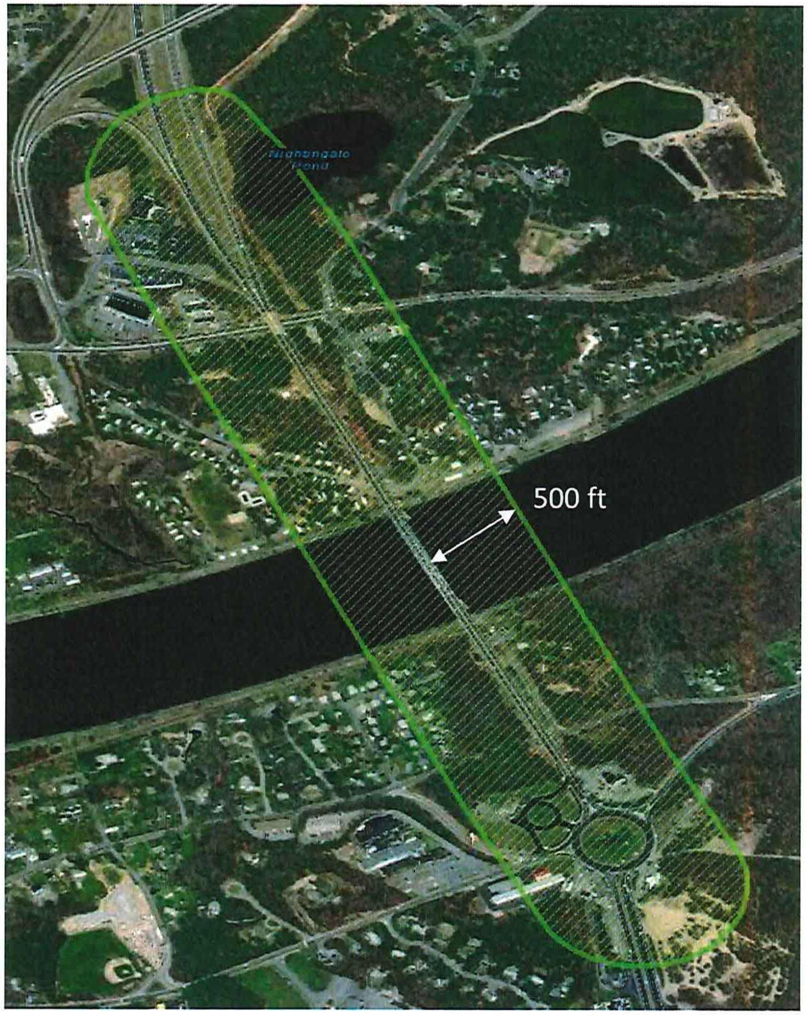
Similar letters sent to:

Ms. Bettina Washington, Tribal Historic Preservation Officer
Wampanoag Tribe of Gay Head (Aquinnah)
20 Black Brook Road
Aquinnah, MA 02535

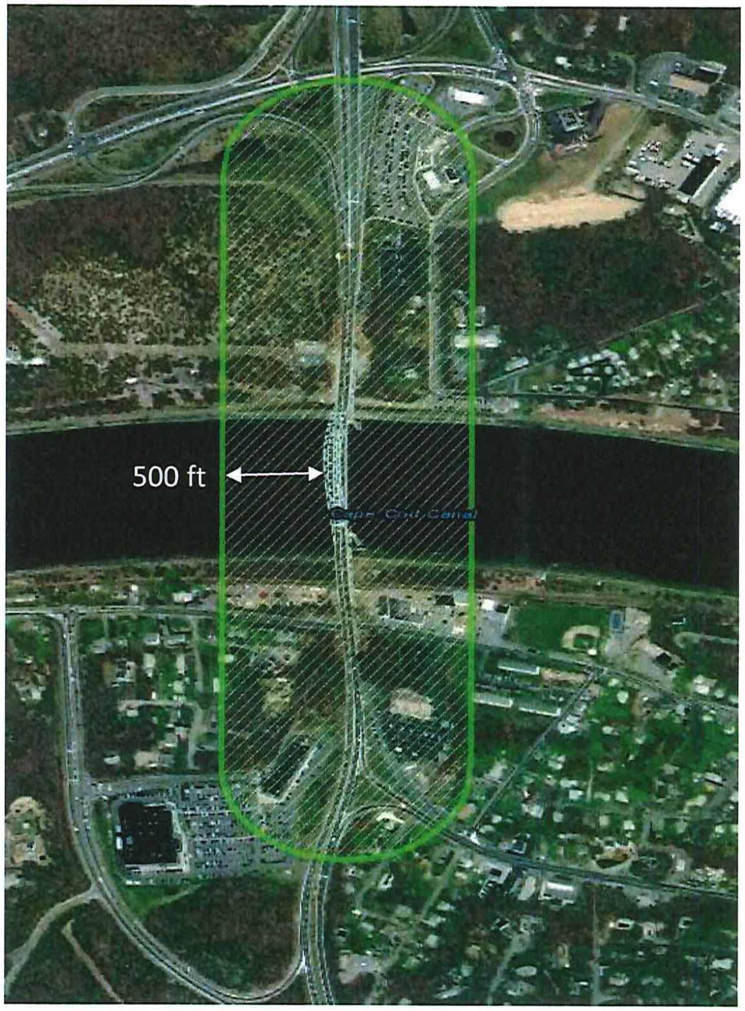
Mr. David Weeden, Tribal Historic Preservation Officer
Mashpee Wampanoag Tribe
483 Great Neck Road South
Mashpee, MA 02649

Map of Existing Bridges and NEPA Survey Areas

BOURNE BRIDGE



SAGAMORE BRIDGE



DEPARTMENT OF THE ARMY
US ARMY CORPS OF ENGINEERS
NEW ENGLAND DISTRICT
696 VIRGINIA ROAD
CONCORD MA 01742-2751

July 17, 2019

Planning Division
Evaluation Branch

Ms. Bettina Washington, Tribal Historic Preservation Officer
Wampanoag Tribe of Gay Head (Aquinnah)
20 Black Brook Road
Aquinnah, MA 02535

Dear Ms. Washington:

The U.S. Army Corps of Engineers (Corps), New England District, is preparing a multi-year Major Rehabilitation Evaluation Study of the Bourne and Sagamore highway bridges spanning the Cape Cod Canal. The study will result in a Major Rehabilitation Evaluation Report (MRER). The MRER will provide the basis of decision making for the Corps and Congress to determine the most cost-effective, safe alternative for critical public transportation access across the Cape Cod Canal.

As part of the MRER, the Corps is preparing an Environmental Assessment (EA) to analyze the potential environmental effects associated with the project. The major rehabilitation study will analyze alternatives to either repair or replace the existing deteriorated Bourne and Sagamore Bridges. The National Environmental Policy Act (NEPA) survey areas are shown in the attached figure.

Currently, the Corps believes that the rehabilitation of the Bourne and Sagamore bridges should have no adverse effect to the bridges and no effect on local historic districts, individual buildings or known and unknown archaeological sites. The major rehabilitation will include replacement of the bridge superstructure, deck replacement, including stringer replacement, abutment span replacement, exterior gusset plate retrofits, interior gusset plate repairs, miscellaneous concrete repairs, suspender cable replacement, paving, and painting. The bridges would continue in their current footprints, and while changes would be made to the bridges, they will look the same after rehabilitation as materials will be replaced in-kind. This effects determination is contingent on the use of previously disturbed laydown and staging areas. If new areas are chosen, an intensive archaeological survey may be required.

During this phase, based on the research completed to date, the replacement of the Bourne and Sagamore Bridges would have an adverse effect on the bridges and at least two identified archaeological sites, possible unidentified archaeological resources,

and several historic districts. The effects would be indirect (visual and/or viewshed) as well as direct (possible archaeological sites).

The MRER decision document and accompanying NEPA document constitutes the initial phase of the major rehabilitation study. Based on the outcome of this study and once an alternative to either repair or replace the existing bridges has been identified, additional analysis will be completed that will allow for more detailed review of project related impacts. Additional coordination will take place with SHPO at that time.

We are requesting your comments on our preliminary determinations of effect. If you have any questions or comments, please contact Kate Atwood, staff archaeologist at (978)318-8537 or via email at Kathleen.a.atwood@usace.army.mil.

Sincerely,

Joseph B. Mackay

Joseph B. Mackay
Acting Chief, Evaluation Branch

Enclosure

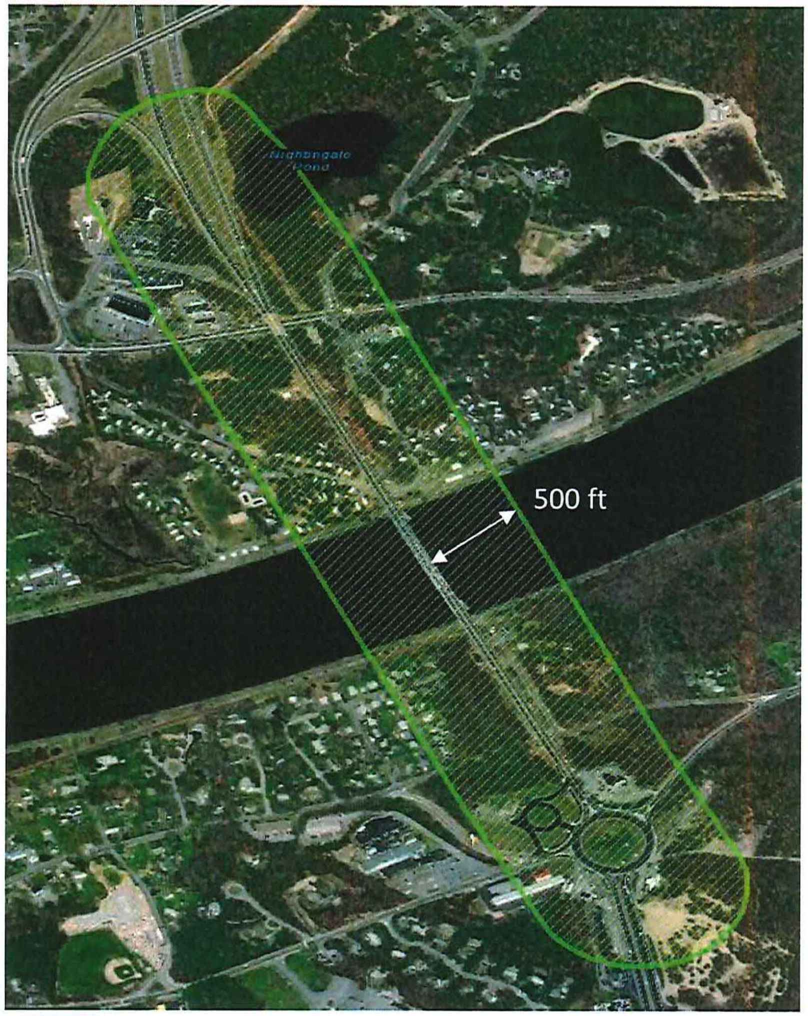
Similar letters sent to:

Mr. David Weeden, Tribal Historic Preservation Officer
Mashpee Wampanoag Tribe
483 Great Neck Road South
Mashpee, MA 02649

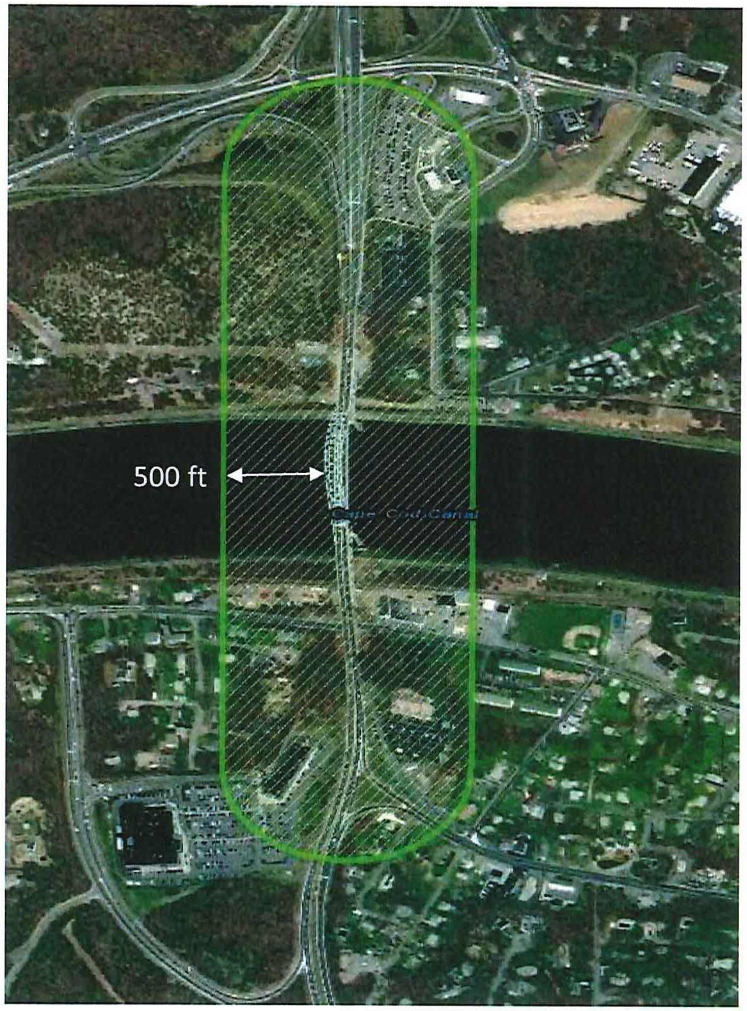
Ms. Brona Simon, State Historic Preservation Officer
Massachusetts Historic Commission
220 Morrissey Boulevard
Boston, MA 02125

Map of Existing Bridges and NEPA Survey Areas

BOURNE BRIDGE



SAGAMORE BRIDGE



DEPARTMENT OF THE ARMY
US ARMY CORPS OF ENGINEERS
NEW ENGLAND DISTRICT
696 VIRGINIA ROAD
CONCORD MA 01742-2751

September 24, 2019

Planning Division
Evaluation Branch

David S. Robinson, Chief Archaeologist, State Underwater Archaeologist
Massachusetts Board of Underwater Archaeological Resources
251 Causeway Street, Suite 800
Boston, MA 02114-2199

Dear Mr. Robinson:

The U.S. Army Corps of Engineers (Corps), New England District, is preparing a multi-year Major Rehabilitation Evaluation Study of the Bourne and Sagamore highway bridges spanning the Cape Cod Canal. The study will result in a Major Rehabilitation Evaluation Report (MRER). The MRER will provide the basis of decision making for the Corps and Congress to determine the most cost-effective, safe alternative for critical public transportation access across the Cape Cod Canal.

As part of the MRER, the Corps is preparing an Environmental Assessment (EA) to analyze the potential environmental effects associated with the project. The major rehabilitation study will analyze alternatives to either repair or replace the existing deteriorated Bourne and Sagamore Bridges. The National Environmental Policy Act (NEPA) survey areas are shown in the attached figure for both rehabilitation and replacement.

Currently, the Corps believes that the rehabilitation of the Bourne and Sagamore bridges should have no adverse effect to the bridges and no effect on local historic districts, individual buildings or known and unknown archaeological sites. The major rehabilitation will include replacement of the bridge superstructure, deck replacement, including stringer replacement, abutment span replacement, exterior gusset plate retrofits, interior gusset plate repairs, miscellaneous concrete repairs, suspender cable replacement, paving, and painting. The bridges would continue to operate in their current footprints, and while changes would be made to the bridges, they will look the same after rehabilitation as materials will be replaced in-kind. This effects determination is contingent on the use of previously disturbed laydown and staging areas. If new areas are chosen, an intensive archaeological survey may be required.

During this initial evaluation, based on the research completed to date, the replacement of the Bourne and Sagamore Bridges would have an adverse effect on the bridges and at least two identified archaeological sites, possible unidentified archaeological resources, and several historic districts. The effects would be indirect (visual and/or viewshed) as well as direct (possible archaeological sites).

The MRER decision document and accompanying NEPA document constitutes the initial phase of the major rehabilitation study. Based on the outcome of this study and an alternative to either repair or replace the existing bridges has been identified, additional analysis will be completed that will allow for more detailed review of project related impacts. Additional coordination will take place with your office at that time.

We are requesting your comments on our preliminary determinations of effect. If you have any questions or comments, please contact Kate Atwood, staff archaeologist at (978) 318-8537 or via email at Kathleen.a.atwood@usace.army.mil.

Sincerely,

Joseph B. Mackay
Acting Chief, Evaluation Branch

Enclosure

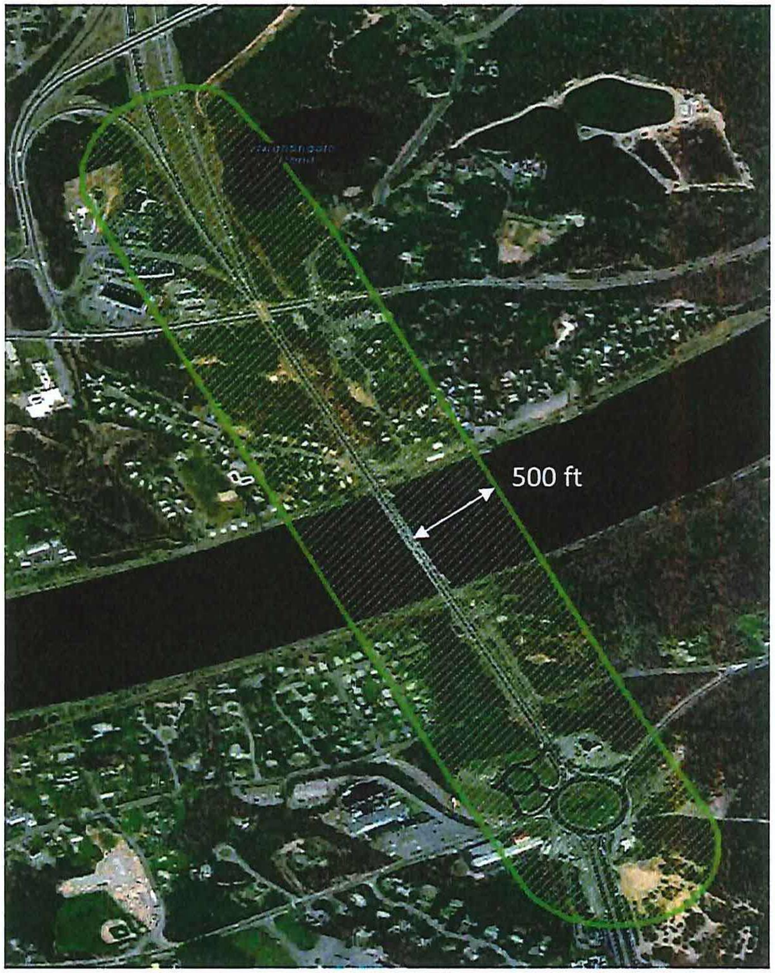
Similar letters sent to:
Ms. Bettina Washington, Tribal Historic Preservation Officer
Wampanoag Tribe of Gay Head (Aquinnah)
20 Black Brook Road
Aquinnah, MA 02535

Mr. David Weeden, Tribal Historic Preservation Officer
Mashpee Wampanoag Tribe
483 Great Neck Road South
Mashpee, MA 02649

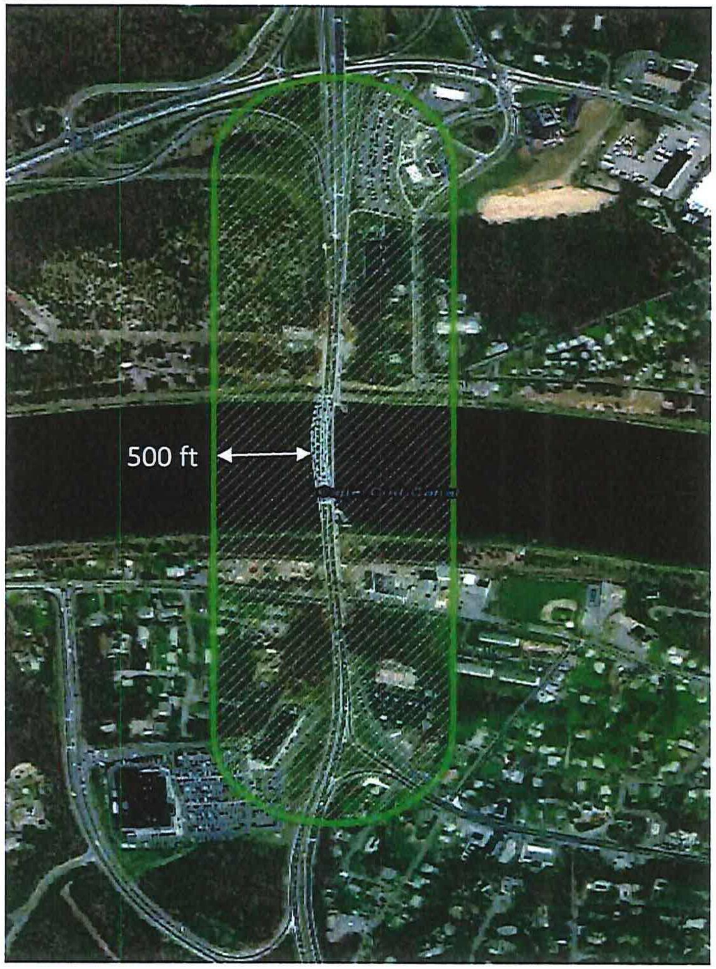
Ms. Brona Simon, State Historic Preservation Officer
Massachusetts Historic Commission
220 Morrissey Boulevard
Boston, MA 02125

Map of Existing Bridges and NEPA Survey Areas

BOURNE BRIDGE



SAGAMORE BRIDGE



This Page Intentionally Left Blank

LOCAL AGENCY COORDINATION

This Page Intentionally Left Blank

From:	Moore, Coreen
To:	Decelles, Elizabeth C CIV USARMY CENAE (US)
Subject:	FW: [Non-DoD Source] Re: [Bourne MA] Cape Cod Canal Bridges Study (Sent by Elizabeth DeCelles, elizabeth.decelles@usace.army.mil)
Date:	Friday, August 9, 2019 3:22:24 PM
Attachments:	Development Projects in Bourne re Canal Bridges Planning 8.9.19.doc

---

Sorry forgot these two
Bourne Police Station and new Wastewater Facility - 35 Armory Road - Buzzards Bay Map 19.4 Parcel 00 and 248

-----Original Message-----
From: Moore, Coreen
Sent: Friday, August 9, 2019 3:08 PM
To: 'Decelles, Elizabeth C CIV USARMY CENAE (US)' <Elizabeth.C.Decelles@usace.army.mil>
Subject: RE: [Non-DoD Source] Re: [Bourne MA] Cape Cod Canal Bridges Study (Sent by Elizabeth DeCelles, elizabeth.decelles@usace.army.mil)

Good Afternoon Elizabeth
Attached are the larger projects in Bourne, either proposed or under construction. Sorry it took so long to get back to you. Hopefully this is helpful for your study

Coreen V. Moore
Bourne Town Planner
Bourne Town Hall
24 Perry Ave.
Buzzards Bay, MA 02532

508.759.0600 ext.#1346

Please remember when writing or responding that the Secretary of State's Office has determined that email is a public record and all e-mail communications sent or received by persons using the Town of Bourne network may be subject to disclosure under the Massachusetts Public Records Law (M.G.L. Chapter 66, Section 10) and the Federal Freedom of Information Act.

-----Original Message-----
From: Decelles, Elizabeth C CIV USARMY CENAE (US) [mailto:Elizabeth.C.Decelles@usace.army.mil]
Sent: Friday, August 9, 2019 10:46 AM
To: Moore, Coreen <CMoore@townofbourne.com>; Bob Gray <sabatia@comcast.net>
Cc: Haines, Samuel <shaines@townofbourne.com>; Bradley, Rosemarie A CIV USARMY CENAE (US) <Rosemarie.A.Bradley@usace.army.mil>; Guerino, Thomas <TGuerino@townofbourne.com>
Subject: RE: [Non-DoD Source] Re: [Bourne MA] Cape Cod Canal Bridges Study (Sent by Elizabeth DeCelles, elizabeth.decelles@usace.army.mil)

Hi Coreen,
Just touching base with you about the major projects in Bourne. We are finishing up our draft next week and need the appropriate information by then to include it. We only need major projects. For example, there were only two in Sandwich. Please don't hestitate to call me if you have questions and thank you so very much for your assistance with this task.

Thanks again,

Elizabeth DeCelles
Ecologist

New England District
U.S. Army Corps of Engineers
(978) 318-8943

-----Original Message-----
From: Moore, Coreen [mailto:CMoore@townofbourne.com]
Sent: Tuesday, July 30, 2019 9:20 AM
To: Decelles, Elizabeth C CIV USARMY CENAE (US) <Elizabeth.C.Decelles@usace.army.mil>; Bob Gray <sabatia@comcast.net>
Cc: Haines, Samuel <shaines@townofbourne.com>; Bradley, Rosemarie A CIV USARMY CENAE (US) <Rosemarie.A.Bradley@usace.army.mil>; Guerino, Thomas <TGuerino@townofbourne.com>
Subject: RE: [Non-DoD Source] Re: [Bourne MA] Cape Cod Canal Bridges Study (Sent by Elizabeth DeCelles, elizabeth.decelles@usace.army.mil)

I am working on your request, it is quite expansive I will send the information as soon as I can

Coreen V. Moore
Bourne Town Planner
Bourne Town Hall
24 Perry Ave.
Buzzards Bay, MA 02532

508.759.0600 ext.#1346

Please remember when writing or responding that the Secretary of State's Office has determined that email is a public record and all e-mail communications sent or received by persons using the Town of Bourne network may be subject to disclosure under the Massachusetts Public Records Law (M.G.L. Chapter 66, Section 10) and the Federal Freedom of Information Act.

-----Original Message-----
From: Decelles, Elizabeth C CIV USARMY CENAE (US) [mailto:Elizabeth.C.Decelles@usace.army.mil]
Sent: Tuesday, July 30, 2019 9:10 AM
To: Bob Gray <sabatia@comcast.net>
Cc: Haines, Samuel <shaines@townofbourne.com>; Moore, Coreen <CMoore@townofbourne.com>; Bradley, Rosemarie A CIV USARMY CENAE (US) <Rosemarie.A.Bradley@usace.army.mil>
Subject: RE: [Non-DoD Source] Re: [Bourne MA] Cape Cod Canal Bridges Study (Sent by Elizabeth DeCelles, elizabeth.decelles@usace.army.mil)

Hi Bob,
Just checking up on the progress of my request for future development plans in the Town of Bourne. We are developing the Environmental Assessment now and it would be great to have your contribution.

Thank you very much,

Elizabeth DeCelles
Ecologist
New England District
U.S. Army Corps of Engineers
(978) 318-8943

-----Original Message-----
From: Bob Gray [mailto:sabatia@comcast.net]

Sent: Tuesday, July 23, 2019 10:14 AM
To: Decelles, Elizabeth C CIV USARMY CENAE (US) <Elizabeth.C.Decelles@usace.army.mil>
Subject: [Non-DoD Source] Re: [Bourne MA] Cape Cod Canal Bridges Study (Sent by Elizabeth DeCelles, elizabeth.decelles@usace.army.mil)

Hi Elizabeth:

Thank you for your inquiry.

The Conservation Commission Agent, Sam Haines and Town Planner, Corrine Moore will contact you soon.

Regards

Sent from my iPhone

> On Jul 23, 2019, at 6:13 AM, Contact form at Bourne MA <cmsmailer@civicplus.com> wrote:
>
> Hello rgray,
>
> Elizabeth DeCelles (elizabeth.decelles@usace.army.mil) has sent you a
> message via your contact form
> (BlockedBlockedBlockedhttps://www.townofbourne.com/users/rgray/contact) at Bourne MA.
>
> If you don't want to receive such e-mails, you can change your
> settings at BlockedBlockedBlockedhttps://www.townofbourne.com/user/686/edit.
>
> Message:
>
> Mr Gray,
>
> We are currently working on the Cape Cod Canal Bridges Major
> Rehabilitation/Replacement Study and accompanying Environmental Assessment.
> We are reaching out to you to ask if th Conservation Commissio is
> aware of any future development plans or projects (commercial,
> residential development, solar/wind power, marinas, etc.) in your
> community, and if so, could you provide us with any general project
> information you might have (project type, size, timing, location, etc.)?
>
> Thank you for any information you can provide.
>
> If it's easier to talk by phone my number is (978) 318-8943.
>
> Elizabeth DeCelles
>

This email has been scanned for spam and viruses by Proofpoint Essentials. Visit the following link to report this email as spam:
BlockedBlockedhttps://gdsprotect.cloud-protect.net/index01.php?
mod_id &mod_option=gitem&mail_id 64492227-
ZKDjjixay6Jk&r_address=oore%40townofbourne.com&report=

This email has been scanned for spam and viruses by Proofpoint Essentials. Visit the following link to report this email as spam:
Blockedhttps://gdsprotect.cloud-protect.net/index01.php?mod_id   &mod_option=gitem&mail_id   65362091-z446CogNC_4g&r_address=oore%40townofbourne.com&report=

TOWN OF BOURNE
Office of the Town Planner
TOWN HALL
24 PERRY AVE.
BUZZARDS BAY, MA 02532
PHONE: 508-759-0600 x1346 ● FAX: 508-759-0611
Email: cmoore@townofbourne.com

COREEN V. MOORE
TOWN PLANNER

Town of Bourne Development Projects

1. 0 Bourne Rotary - Map 25 Parcel 44 - currently vacant - 85,000 sf commercial and 300 residential units permitted
2. 4 & 6 MacArthur Blvd - Map 24 Parcel 19 - redevelopment Cumberland Farms with 8140 square feet of retail and ten gas pumps permitted currently under appeal
3. 220 Sandwich Road – Map 25 Parcel 1 - Upper Cape Technical School proposed addition to Nursing Building and a new veterinary building
4. 370 Scenic Highway Bourne Scenic Park - proposed new wastewater system
5. 230 Sandwich Road – Map 25 Parcel 9 - Proposed affordable housing development permitted 16 unit current request for modification for 20 units
6. 340 Scenic Highway – Map 20.4 Parcel 6 - development proposal gas station phase two extended stay hotel – not yet permitted
7. Off Perry Ave – Downtown – Map 24.1 Parcel 6 - 100 room Hampton Inn – under construction
8. Off Perry Ave – Downtown – Map 24.1 Parcel 5 – 120 senior living apartments under construction
9. Cape View Way – Sagamore – Map 7 Parcel 85-90 – Proposed 55 affordable family apartments – planning stages
10. Off Scenic Highway - Map 10 Parcel 10 - Cape Cod Aggregate gravel operation currently carrying out closure

Sincerely,

Coreen V. Moore

Coreen V. Moore

Town Planner

From: Drake, Leanne
To: Decelles, Elizabeth C CIV USARMY CENAE (US)
Subject: [Non-DoD Source] RE: New Projects in Sandwich
Date: Wednesday, July 24, 2019 8:36:27 AM

They have a new unit up and operating but I'm not sure if they are planning anymore expansions at this time. I will check in with the Building Department and follow up with you if I hear otherwise.

Thanks,
Leanne

Leanne Drake
Assistant Town Planner
Planning & Economic Development
Town of Sandwich
16 Jan Sebastian Drive
Sandwich, MA 02563
(508) 833-8001

-----Original Message-----
From: Decelles, Elizabeth C CIV USARMY CENAE (US) [mailto:Elizabeth.C.Decelles@usace.army.mil]
Sent: Wednesday, July 24, 2019 6:28 AM
To: Drake, Leanne
Subject: RE: New Projects in Sandwich

Hi again Leanne,
Do you happen to know of any plans going on at the Canal Generating Plant located along the Canal?

Elizabeth DeCelles
Ecologist
New England District
U.S. Army Corps of Engineers
(978) 318-8943

-----Original Message-----
From: Drake, Leanne [mailto:ldrake@townofsandwich.net]
Sent: Tuesday, July 23, 2019 3:07 PM
To: Decelles, Elizabeth C CIV USARMY CENAE (US) <Elizabeth.C.Decelles@usace.army.mil>
Subject: [Non-DoD Source] New Projects in Sandwich

Hi Elizabeth,

Sorry I am only getting back to you know. I'm looking through our applications and there are only 2 large scale projects in the works:

- Wing School - we have sent out an RFP for the school in the hopes it will be redeveloped
- 180 Cotuit Road - Large scale solar photovoltaic project currently with the Cape Cod Commission

Other than those two most of our development residential single family or extensions to existing homes.

Hope this helps.

Thanks,

Leanne

Leanne Drake

Assistant Town Planner

Planning & Economic Development

Town of Sandwich

16 Jan Sebastian Drive

Sandwich, MA 02563

(508) 833-8001

This email has been scanned by the Symantec Email Security.cloud service.
For more information please visit BlockedBlockedhttp://www.symanteccloud.com

---

This email has been scanned by the Symantec Email Security.cloud service.
For more information please visit Blockedhttp://www.symanteccloud.com

---

This email has been scanned by the Symantec Email Security.cloud service.
For more information please visit Blockedhttp://www.symanteccloud.com

---

RESPONSES TO DRAFT

This Page Intentionally Left Blank

DEPARTMENT OF THE ARMY
US ARMY CORPS OF ENGINEERS
NEW ENGLAND DISTRICT
696 VIRGINIA ROAD
CONCORD MA 01742-2751

October 7, 2019

Programs and Project Management Division
Civil Works/ IIS Branch

To Whom It May Concern:

The U.S. Army Corps of Engineers (USACE), New England District, has conducted a multi-year Major Rehabilitation Evaluation Study of the Bourne and Sagamore highway bridges spanning the Cape Cod Canal. The USACE has released a draft Major Rehabilitation Evaluation Report (MRER) and Environmental Assessment (EA) for public review and comment. The MRER provides the basis of decision making for USACE to determine the most cost-effective, safe alternative for critical public transportation access across the Cape Cod Canal. The EA was prepared to analyze the potential environmental effects associated with the project.

The major rehabilitation study analyzed alternatives to either rehabilitate or replace the existing Bourne and Sagamore highway bridges. This letter notifies you of our request for your comments on the draft MRER and EA for the project. The draft documents and appendices include maps of the proposed project area, a project description, resource characterizations of the project area, and resource agency coordination. We would appreciate receipt of your comments within 30 days of receipt of this letter.

The preferred alternative for this project proposes the replacement of both highway bridges with new bridges (consisting of 4 through traffic lanes and 2 auxiliary lanes) to be constructed adjacent to the existing bridges. Design of the new highway bridges will incorporate modern federal highway safety standards such as increased travel lane widths, pedestrian and bicycle lanes with vehicle lanes separation barrier, medians between the two directions of vehicular travel, and shoulders to accommodate vehicle breakdowns. To minimize impacts to connecting roads, other non-Federal highways, and local roadways, each new bridge would be placed along approximately the same alignment as the existing bridges. The current bridges would remain open and continue to be inspected and maintained in a safe and reliable state while construction of the new bridges is underway. The current bridges would be dismantled and removed once the new bridges have been opened to traffic. The actual type, design, and location of any proposed new bridges will be determined, and any related potential impacts further evaluated, in the next phase of the Cape Cod Canal Highway Bridges Project.

The recommendations contained in the Draft MRER/EA reflect the information available at this time and current policies governing formulation of individual projects. They do not reflect program and budgeting priorities inherent in the development of a National Civil Works construction program nor the perspective of higher review levels within the Executive Branch. Consequently, the recommendations may be modified before they are transmitted to Congress as proposals for authorization and implementation funding. However, prior to transmittal to

Congress, all a parties will be advised of any modifications and would be afforded an opportunity for further comment.

A copy of the Public Notice of Availability for the project is enclosed, along with a CD containing the draft MRER / EA. We look forward to your participation in this project and if you or your staff have any questions or require additional information regarding the EA, please contact Rosemarie Bradley, Environmental Compliance Lead at 978-318-8127 or by e-mail at rosemarie.a.bradley@usace.army.mil or Craig Martin, Project Manager at 978-318-8638 or by email at craig.a.martin@usace.army.mil.

Sincerely,

Wendy Gendron
Chief, Civil / IIS Branch

Enclosures
CD with Draft MRER/EA
Public Notice

Copy Furnished

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 1
5 POST OFFICE SQUARE, SUITE 100
BOSTON, MA 02109-3912

OFFICE OF THE
REGIONAL ADMINISTRATOR

November 14, 2019

Craig Martin
U.S. Army Corps of Engineers
New England District
696 Virginia Road
Concord, MA 01742-2751

RE: Cape Cod Canal Highway Bridges Draft Major Rehabilitation Evaluation Report and Draft Environmental Assessment, Bourne, Massachusetts

Dear Mr. Martin:

We are writing in response to your October 9, 2019 30-day Public Notice requesting comments on the Draft Environmental Assessment (EA) for the Cape Cod Canal Highway Bridges in Bourne, Massachusetts. We submit the following response to the EA in accordance with our responsibilities under the National Environmental Policy Act (NEPA) and Section 309 of the Clean Air Act.

The EA was prepared to support decision-making by the U.S. Army Corps of Engineers regarding the identification of a long-term maintenance and operation strategy for the Bourne and Sagamore bridges which were originally constructed in the 1930s. Specifically, the EA evaluates "…whether continued repair and maintenance, major rehabilitation, or replacement of the bridges with new structures will provide safe, efficient transit for vehicular traffic across the Cape Cod Canal." Alternatives considered in the EA include continued bridge repair and maintenance, major rehabilitation, or replacement of the bridges. The EA identifies replacement of both the Bourne and Sagamore Bridges (with four primary and two auxiliary lanes) as the preferred alternative. We have no objections to the selection of the bridge replacement alternative. While the general information provided in the EA is suitable to support decision-making regarding the future plans for both bridges it does not detail the specific impacts of the replacement work. Based on our review of the EA it is our understanding that this information will be provided as part of future NEPA analysis and documentation for the project. As such we recommend that the next phase of the NEPA analysis for the project provide:

- A specific description of staging/laydown areas and alternatives considered for this component of the project construction and demolition work.

- A specific description of construction sequencing for the bridge replacement projects with a focus on the potential for environmental and host community effects including affects on local and regional traffic.

- A comprehensive description of impacts to the Cape Cod Canal and wetland areas affected by the proposed work including a discussion of measures taken to avoid or minimize impacts through project design or best management practices. This discussion should also expand on the discussion in the current EA regarding potential impacts to Nightingale Pond.

- A specific description of how stormwater will be managed during construction and operation of the proposed replacement bridges. The analysis should address both quantitative and qualitative aspects of stormwater management over the life of the proposed project and demonstrate how new bridges will meet water quality/stormwater management regulations. A comparison of existing stormwater management techniques at each bridge location to the proposed condition will serve to highlight additional benefits of the bridge replacement work.

We are willing to work with the Corps as appropriate to help determine appropriate ways to address the issues identified in this letter during the next phase of the project. Please let us know how we can be of assistance. We would also appreciate the opportunity to review and comment on the NEPA scope of analysis for the next phase of the project when appropriate. Thank you for the opportunity to comment on this EA. Please contact me at 617-918-1025 with any comments or questions.

Sincerely,

Timothy L. Timmermann
Director, Office of Environmental Review

THE COMMONWEALTH OF MASSACHUSETTS
EXECUTIVE OFFICE OF ENERGY AND ENVIRONMENTAL AFFAIRS
OFFICE OF COASTAL ZONE MANAGEMENT
251 Causeway Street, Suite 800, Boston, MA 02114-2136
(617) 626-1200 FAX: (617) 626-1240

November 26, 2019

Mr. Craig Martin
U.S. Army Corps of Engineers
New England District
696 Virginia Road
Concord, MA 01742-2751

Re: CZM Federal Consistency Review of Major Rehabilitation Evaluation Report and accompanying Draft Environmental Assessment for the Cape Cod Canal Bridges, Cape Cod Canal Federal Navigation Project; Bourne.

Dear Mr. Martin:

The Massachusetts Office of Coastal Zone Management (CZM) has completed its review of the Major Rehabilitation Evaluation Report and accompanying Draft Environmental Assessment to ensure consistency with CZM enforceable program policies.

Based upon our review of applicable information, we concur with your certification and find that the activity as proposed is consistent with the CZM enforceable program policies.

If the above-referenced project is modified in any manner, including any changes resulting from permit, license or certification revisions, including those ensuing from an appeal, or the project is noted to be having effects on coastal resources or uses that are different than originally proposed, it is incumbent upon the proponent to notify CZM, submit an explanation of the nature of the change pursuant to 15 CFR 930, and submit any modified state permits, licenses, or certifications. CZM will use this information to determine if further federal consistency review is required.

Thank you for your cooperation with CZM.

Sincerely,

Lisa Berry Engler

Lisa Berry Engler
Director

RLB/pb
CZM# 18834

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 1
5 POST OFFICE SQUARE, SUITE 100
BOSTON, MA 02109-3912

OFFICE OF THE
REGIONAL ADMINISTRATOR

November 14, 2019

Craig Martin
U.S. Army Corps of Engineers
New England District
696 Virginia Road
Concord, MA 01742-2751

RE: Cape Cod Canal Highway Bridges Draft Major Rehabilitation Evaluation Report and Draft Environmental Assessment, Bourne, Massachusetts

Dear Mr. Martin:

We are writing in response to your October 9, 2019 30-day Public Notice requesting comments on the Draft Environmental Assessment (EA) for the Cape Cod Canal Highway Bridges in Bourne, Massachusetts. We submit the following response to the EA in accordance with our responsibilities under the National Environmental Policy Act (NEPA) and Section 309 of the Clean Air Act.

The EA was prepared to support decision-making by the U.S. Army Corps of Engineers regarding the identification of a long-term maintenance and operation strategy for the Bourne and Sagamore bridges which were originally constructed in the 1930s. Specifically, the EA evaluates "…whether continued repair and maintenance, major rehabilitation, or replacement of the bridges with new structures will provide safe, efficient transit for vehicular traffic across the Cape Cod Canal." Alternatives considered in the EA include continued bridge repair and maintenance, major rehabilitation, or replacement of the bridges. The EA identifies replacement of both the Bourne and Sagamore Bridges (with four primary and two auxiliary lanes) as the preferred alternative. We have no objections to the selection of the bridge replacement alternative. While the general information provided in the EA is suitable to support decision-making regarding the future plans for both bridges it does not detail the specific impacts of the replacement work. Based on our review of the EA it is our understanding that this information will be provided as part of future NEPA analysis and documentation for the project. As such we recommend that the next phase of the NEPA analysis for the project provide:

- A specific description of staging/laydown areas and alternatives considered for this component of the project construction and demolition work.
- A specific description of construction sequencing for the bridge replacement projects with a focus on the potential for environmental and host community effects including affects on local and regional traffic.

- A comprehensive description of impacts to the Cape Cod Canal and wetland areas affected by the proposed work including a discussion of measures taken to avoid or minimize impacts through project design or best management practices. This discussion should also expand on the discussion in the current EA regarding potential impacts to Nightingale Pond.

- A specific description of how stormwater will be managed during construction and operation of the proposed replacement bridges. The analysis should address both quantitative and qualitative aspects of stormwater management over the life of the proposed project and demonstrate how new bridges will meet water quality/stormwater management regulations. A comparison of existing stormwater management techniques at each bridge location to the proposed condition will serve to highlight additional benefits of the bridge replacement work.

We are willing to work with the Corps as appropriate to help determine appropriate ways to address the issues identified in this letter during the next phase of the project. Please let us know how we can be of assistance. We would also appreciate the opportunity to review and comment on the NEPA scope of analysis for the next phase of the project when appropriate. Thank you for the opportunity to comment on this EA. Please contact me at 617-918-1025 with any comments or questions.

Sincerely,

Timothy L. Timmermann
Director, Office of Environmental Review

U.S. Department
of Transportation
**Federal Highway
Administration**

Massachusetts Division

55 Broadway, 10th Floor
Cambridge, MA 02142
(617) 494-3657
(617) 494-3355
www.fhwa.dot.gov/madiv

December 19, 2019

In Reply Refer To:
HDA-MA

William M. Conde
Colonel, Corps of Engineers
District Engineer
U.S. Army Corps of Engineers
New England District
696 Virginia Road
Concord, MA 01742

Subject: Comments on Major Rehabilitation Evaluation Report (MRER) and Environmental Assessment for the Cape Cod Canal Bridges Study

Dear Colonel Conde:

On November 1, 2018, the Federal Highway Administration's Massachusetts Division Office (FHWA) received an invitation from your agency to become a Cooperating Agency on the subject project. On November 28, 2018, we responded and accepted your invitation. As a Cooperating Agency we offer the following comments.

Regarding the National Environmental Policy Act (NEPA) Environmental Assessment (EA), please be aware that if federal-aid highway funding is anticipated to be used in future stages of the project then some supplemental NEPA analysis will need to be conducted.

Regarding the MRER, we offer the following observations:

- In order to maintain federal-aid highway funding eligibility, the design for this project shall be in accordance with Title 23 Code of Federal Regulations (CFR) Part 625 – Design Standards for Highways; and Title 23 CFR Part 650 Bridges, Structures, and Hydraulics. This includes the American Association of State Highway and Transportation Officials (AASHTO) Policy on Geometric Design of Highway and Streets (also known as "the Green Book") and the relevant AASHTO bridge design criteria. The Transportation Research Board of the National Academies of Science Highway Capacity Manual should also be used for operational analysis.
- Major bridges of this height and span have a minimum design life of 75 years often with 100 years preferred. The MRER only used a 50-year timeframe for analysis. The design should be based on the longer timeframe.
- Based on the close proximity of the interchanges and intersections at the end of each bridge, current standards for this type of facility include acceleration and deceleration lanes (also known as auxiliary lanes) going onto the bridges in most, if not all, four ends

of the bridges. In final design, analysis will need to be done to determine if the auxiliary lanes should be continuous across each bridge for operational weaving and structural efficiency needs. Depending on the structure type, long span bridges such as these may gain cost efficiency with a uniform width.

Based on the scope of the project, design life expectancy, traffic volumes and operations, and modern design standards, a four-lane bridge alternative does not appear to be practicable without high costs and impacts to significantly reconfigure the approach roadway system. The six-lane alternative will provide the necessary flexibility for a final design to meet modern design standards with a 75- to 100-year design life while minimizing the property, environmental and cost impacts.

If you have any questions or comments, please contact me at (617) 494-1788 or Cassandra Ostrander at (617) 494-3113. We look forward to continuing to participate as a Cooperating Agency on this project.

Sincerely,

Jeffrey H. McEwen, P.E.
Division Administrator

cc: Craig Martin
Rosemarie Bradley

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
GREATER ATLANTIC REGIONAL FISHERIES OFFICE
55 Great Republic Drive
Gloucester, MA 01930-2276

DEC 2 0 2019

Wendy Gendron
Chief, Civil Works/IIS Branch
Department of the Army, Corps of Engineers
New England District
696 Virginia Road
Concord, MA 01742-2751

Re: Draft Major Rehabilitation Evaluation Report and Environmental Assessment for the Bourne and Sagamore Bridges

Dear Ms. Gendron:

Thank you for your letter, dated November 6, 2019, requesting our review of the Draft Major Rehabilitation Evaluation Report (MRER) and Environmental Assessment (EA) for the Bourne and Sagamore Bridges spanning the Cape Cod Canal.

As we noted in an email to Rosemarie Bradley on November 19, 2019, the sections of the EA addressing Endangered Species Act (ESA) resources accurately catalog the listed species and critical habitat under our jurisdiction that are present in your project action area. You also correctly included that our chief concern, regardless of the selected alternative, is the safe passage of the endangered North Atlantic right whale, which occasionally migrate through the Canal. It is our understanding that you will work with us to develop protection measures for ESA-listed species during the design phase of the project. We would like to clarify that while you include humpback whales among the listed species that may be present in your action area, the distinct population segment (DPS) of humpback whales expected to be present in the action area (West Indies DPS) is no longer listed as threatened or endangered under the ESA (though it is still protected under the Marine Mammal Protection Act).

Your Draft MRER EA also accurately identifies the project elements that will be of highest concern for potential impacts to essential fish habitat (EFH). We look forward to working with you to ensure impacts to EFH are minimized as the project is fully developed. We do note that there appear to be some issues with the included list of managed fish species with designated EFH in the project area (EA Table 2). The list of species embedded in EA Figure 9, more accurately identifies the species with designated EFH. However, it is missing spiny dogfish and northern shortfin squid. The figure list also states that all life history stages of the species listed occur, but there are multiple species that do not have all life history stages designated in the project area. We would be happy to work with you to develop the full list of species with designated EFH in the project area.

Thank you for the opportunity to review and comment on the Draft MRER EA. We look forward to our continued work with you. If you have any questions regarding this matter, please contact

Alison Verkade at (978) 281-9266 or by email at Alison.Verkade@noaa.gov for information regarding Essential Fish Habitat or other trust resources, or Zach Jylkka at (978) 282-8467 or by email at Zachary.Jylkka@noaa.gov for information regarding threatened and endangered species listed by us under the ESA.

Sincerely,

Jennifer Anderson
Assistant Regional Administrator
for Protected Resources

EC: Verkade, NMFS HCD; Bradley, Martin, Randall, USACE
File Code: H:\Section 7 Team\Section 7\Non-Fisheries\ACOE\Informal\2019\New England\Cape Cod Canal Bridge Replacement\Pre-Consultation

Charles D. Baker, Governor
Karyn E. Polito, Lieutenant Governor
Stephanie Pollack, Secretary & CEO
Jonathan L. Gulliver, Highway Administrator

massDOT
Massachusetts Department of Transportation
Highway Division

January 22, 2020

William M. Conde
Colonel, Corps of Engineers
District Engineer
U.S. Army Corps of Engineers
New England District
696 Virginia Road
Concord, MA 01742

Subject: Comments on Major Rehabilitation Evaluation Report (MRER) and Environmental Assessment for the Cape Cod Canal Bridges Study

Dear Colonel Conde:

On November 1, 2018, The Massachusetts Department of Transportation (MassDOT) received an invitation from your agency to become a Cooperating Agency on the subject project. On August 29, 2019, MassDOT responded and accepted your invitation. As a Cooperating Agency we offer the following comments on the MRER:

(1) We concur with the MRER's conclusions and the recommendation in FHWA's, letter dated December 19, 2019, that the preferred alternative is Plan D – Replacement of bridges with 6 lanes (4 lanes plus 2 auxiliary lanes).

Comment 3 of FHWA's letter states:

> Based on the close proximity of the interchanges and intersections at the end of each bridge, current standards for this type of facility include acceleration and deceleration lanes (also known as auxiliary lanes) going onto the bridges in most, if not all, four ends of the bridges. In final design, analysis will need to be done to determine if the auxiliary lanes should be continuous across each bridge for operational weaving and structural efficiency needs pending on the structure type, long span bridges such as these may gain cost efficiency with a uniform width.

The design requirements used for the roadways, intersections, and interchanges shall be in accordance with and the 2006 MassDOT Project Development and Design Guide as well as 2018 American Association of State Highway and Transportation Officials (AASHTO) Policy on Geometric Design of Highway and Streets ("the Green Book"). See Chapter 10 of The Green Book which includes Tables 10-4 *Minimum Acceleration Lane Lengths for Entrance Terminals*…, Table 10-5 *Speed Change Lane adjustment factors as a function of grade*…, and Table 10-6 *Minimum deceleration lane lengths for* *exit terminals*…; these dictate the required lengths for this type of facility include acceleration and deceleration lanes (also known as auxiliary lanes).

(2) Anticipating that MassDOT will be the owner of the future bridges after replacement, the Highway Division will be fully engaged throughout the design and construction process on this critical piece of infrastructure. The desire would be to meet or exceed all of the bridge design standards, including the MassDOT Bridge Manual, LRFD, PDDG and all governing design guidelines.

(3) There are many participating agencies, and the level of commitment to the project by these agencies are yet to be determined.

(4) The necessary permitting will adhere to both NEPA and MEPA requirements for both the replacement bridges as well as the approach roadways and ancillary transportation improvements.

MassDOT looks forward to close communication with the U.S. Army Corps of Engineers during the Phase 2 process to help facilitate the Federal and State environmental regulatory and permitting processes. MassDOT is currently working with multiple design consultants for both preliminary design, environmental delineation and survey/base mapping in the Cape Cod Canal Area. That information and data collection will be shared with USACE in the coming months to facilitate the design development process.

If you have any questions or would like additional information, please do not hesitate to contact Andrew Paul in MassDOT's Highway Design office at 857-368-9450 or andrew.paul@state.ma.us

Sincerely,

Jonathan Gulliver
Highway Administrator

Cc: John Bechard, Deputy Chief Engineer of Project Development
Andrew Paul, Highway Design Engineer

United States Department of the Interior

FISH AND WILDLIFE SERVICE

New England Field Office
70 Commercial Street, Suite 300
Concord, NH 03301-5087
http://www.fws.gov/newengland

December 23, 2019

Wendy Gendron
Programs and Project Management Division
Civil Works/IIS Project Management Branch
U.S. Army Corps of Engineers
New England District
696 Virginia Road
Concord, MA 01742-2751

Ref: Major Rehabilitation Evaluation Report and Environmental Assessment
for the Bourne and Sagamore Highway Bridges (Bourne, MA)
TAILS: 2020-I-0427

Dear Ms. Gendron:

This responds to your correspondence, dated November 5, 2019, and received in our office on November 12, 2019, requesting our review of the above referenced documents. Your request and our response are made pursuant to section 7 of the Endangered Species Act of 1973, as amended (87 Stat. 884, as amended; 16 U.S.C. 1531, *et seq.*; ESA), and section 2(b) of the Fish and Wildlife Coordination Act of 1934, as amended (16 U.S.C. 661-667e).

The U.S. Army Corps of Engineers (Corps) developed an Environmental Assessment (EA) that accompanies the Major Rehabilitation Evaluation Report as the first phase in determining the future of the Cape Cod Canal Highway Bridges. This phase examines potential alternatives at a conceptual level; the Corps will develop a more definitive design in the next phase of analysis. The footprint of the proposed project will include the Bourne and Sagamore bridges plus a 500-foot buffer zone around each, totaling 305 acres.

The proposed project, regardless of the final alternative selection and subsequent design, will largely occur within the footprint of existing developed land (i.e., the bridges and their supporting structures), and therefore, is unlikely to have substantial impacts on wildlife or their habitat. However, we encourage the Corps to consider listed and other high priority species during the planning and implementation of this project, and to pursue any design elements that would minimize impacts and/or provide beneficial impacts to these species or their habitats.

"At-Risk" Species

The following species are not currently listed under the ESA, but they are considered to be at-risk of needing that protection, and they could occur in the vicinity of the proposed project: New England cottontail (*Sylvilagus transitionalis*), frosted elfin butterfly (*Callophrys irus*), wood turtle (*Glyptemys insculpta*), and spotted turtle (*Clemmys guttata*). More information and recommendations for specific conservation measures that may be taken to support these species is available from the Massachusetts Division of Fisheries and Wildlife (https://www.mass.gov/info-details/list-of-endangered-threatened-and-special-concern-species).

Federally Listed Species

The proposed project falls within the range of the federally threatened northern long-eared bat (NLEB; *Myotis septentrionalis*), piping plover (*Charadrius melodus*), and red knot (*Calidris canutus*); and the federally endangered northern (Plymouth) red-bellied cooter (*Pseudemys rubriventris*), American chaffseed (*Schwalbea americana*), and roseate tern (*Sterna dougallii dougallii*). With the exception of the NLEB, the Corps determined the proposed project, regardless of the final alternative selection and subsequent design, will have no effect on these species, because habitat for these species is not present in the project area.

In regard to the NLEB, we recommend the Corps consult with the Service, pursuant to section 7 of the ESA, during the design phase of the project to determine if NLEB are present and identify measures to minimize potential impact, as documented on page 39 of the EA.

Thank you for your coordination. We look forward to continuing to work with you as this project develops. Please contact Ms. Cindy Corsair of this office at 401-213-4416 if we can be of further assistance.

Sincerely yours,

acting for
Thomas R. Chapman
Supervisor
New England Field Office

cc: Reading file
ES: CCorsair:jd:12-23-19:401-213-4416

This Page Intentionally Left Blank

MassDOT CAPE COD CANAL TRANSPORTATION STUDY PRELIMINARY AIR QUALITY EVALUATION

This Page Intentionally Left Blank

HMMH
77 South Bedford Street
Burlington, Massachusetts 01803
781.229.0707
www.hmmh.com

MEMORANDUM

To:	Michael Paiewonsky Stantec 226 Causeway Street, 6th Floor, Boston, MA 02114
From:	Philip DeVita, Principal Consultant
Date:	February 20, 2018
Subject:	Cape Cod Canal Transportation Improvements Study Preliminary Air Quality Evaluation
Reference:	HMMH Project Number 308230

This memorandum summarizes the methods and findings of the preliminary air quality evaluation conducted for the Cape Cod Canal Transportation Improvements Study. The evaluation was conducted based on the conceptual design of potential transportation improvements and future year (2040) traffic forecasts. As such, the study did not include roadway prediction modeling of air quality levels with the U.S. Environmental Protection Agency (EPA) and Federal Highway Administration (FHWA) approved air quality models. Instead, a more qualitative evaluation was conducted to assess the potential for increased or decreased air quality impacts within the study areas utilizing EPA and FHWA guideline criteria.

A detailed air quality study would be conducted during the preparation of an environmental document for future projects once the number of alternatives has been narrowed, and the alternatives selected for study have been refined. These future detailed air quality analysis' would evaluate existing and future air quality impacts associated with project roadways. Impacts will be assessed with respect to the methodologies and assumptions for each pollutant consistent with FHWA and EPA guidance as well as that of the Massachusetts Department of Transportation (MassDOT) and Massachusetts Department of Environmental Protection (MassDEP).

Preliminary Air Quality Evaluation Methodology

HMMH reviewed proposed roadway improvements in connection with four future Build scenarios under study, designated Cases 1, 2, 3 and 3A. Case 3A is considered to be the most complete improvement scenario, and includes the replacement of both the Bourne and Sagamore Bridges. Case 2 represents the complete mid-term improvements, including most of the improvements in Case 3A but without the replacement of the Canal bridges, the relocation of Route 6 Exit 1C, or the addition of an additional westbound travel lane on Route 6.

Consistent with the noise approach, Case 2 and Case 3A were chosen for the air quality assessment. Modeled traffic impacts were also reviewed for the summer and non-summer conditions for each Build Scenario. It was determined the worst-case conditions (i.e. higher traffic volumes) occur during the summer peak period which would correlate to higher (i.e. worst case) air quality impacts. Therefore, HMMH assumed worst-case summer peak period traffic conditions when evaluating Case 2 and Case 3A Alternatives.

Accordingly, a qualitative carbon monoxide (CO), Mobile Source Air Toxics (MSATs), greenhouse gas (GHG), and ozone precursor's volatile organic compounds (VOCs) and nitrogen oxides (NOx) analysis have been prepared. The EPA has designated the Project Area as being in attainment for all the National Ambient Air Quality Standards (NAAQS); therefore, transportation conformity requirements do not apply for this project.

Carbon Monoxide: Analysis for potential impacts for CO was conducted for the roadway and associated intersections that might be impacted by the project for the Existing, future No Build, Build Case 2, and Build Case 3A conditions. Typically, CO is used in microscale studies to indicate roadway pollutant levels since it is the most abundant pollutant emitted by motor vehicles and can result in so-called "hot spot" (high concentration) locations around congested intersections.

Comparison of average daily peak hour (AM and PM) volumes and Level of Service (LOS) along with expected delay and vehicle hours traveled (VHT) at each intersection were conducted for each Alternative and are included in Table 1. A total of twelve intersections were included in the analysis, which were comprised of both existing and future intersections.

Analysis of Table 1 shows that, in general, the LOS for the Peak AM and PM conditions either stay the same or is worse for Case 2 and Case 3A when compared to the future No Build conditions. Similarly, the intersection Peak AM and PM delay, peak volumes and VHT also generally increased for the two Build Alternatives compared to the No Build conditions. There were only a few intersections where the LOS, peak hourly volumes and delay were expected to improve with the Build Conditions compared to the No build. Those intersections were:

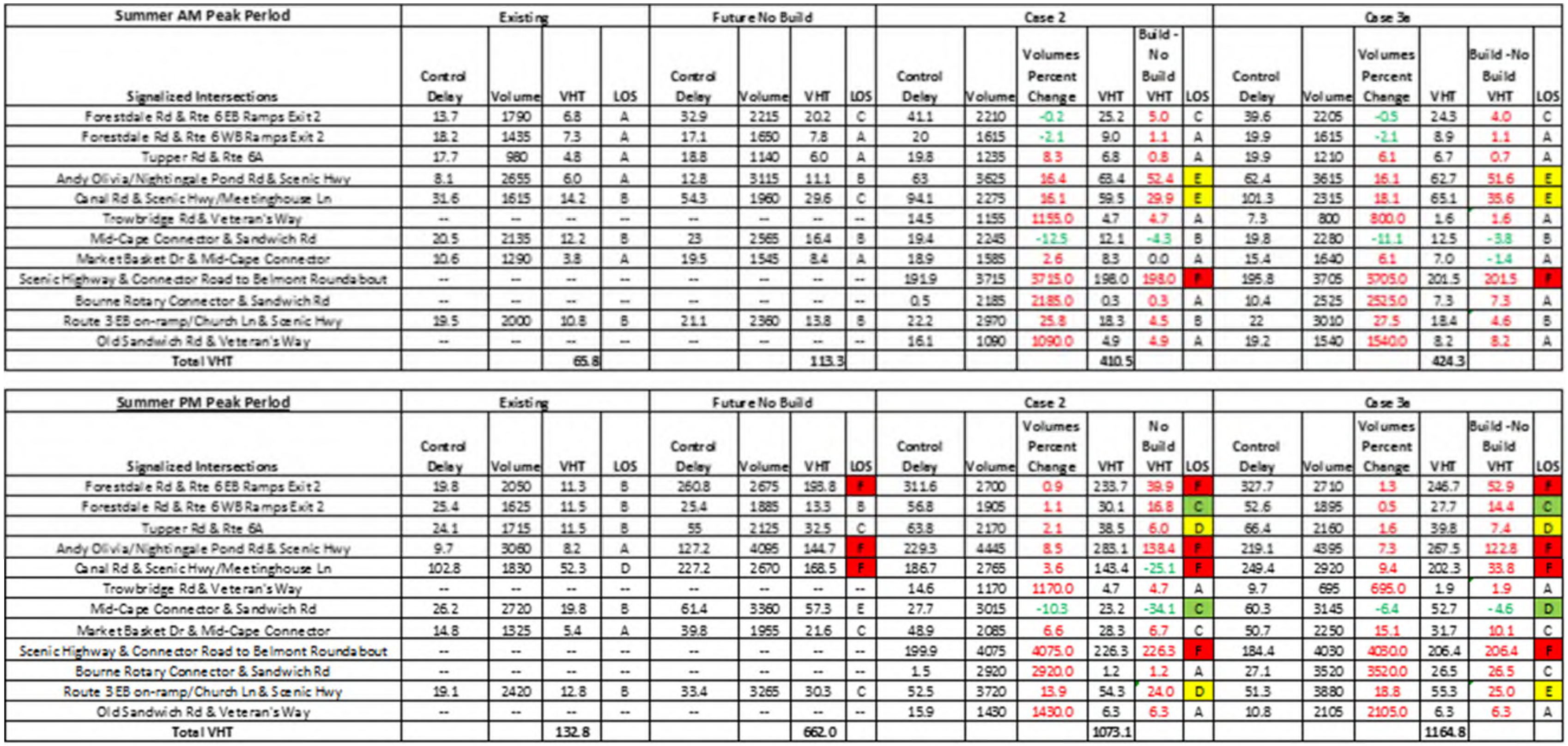
1. Forestdale Rd & Route 6 EB Ramps Exit 2
2. Forestdale Rd & Route 6 WB Ramps Exit 2
3. Mid-Cape Connector & Sandwich Rd

The Market Basket Drive & Mid-Cape Connector intersection is also expected to show a slight VHT improvement for the AM condition only under Case 3A as well as the Canal Road & Scenic Hwy/Meetinghouse Lane intersection where a reduction in VHT is expected in the PM only under Case 2. All the remaining intersections are expected to either remain the same or result in a higher LOS, delay and VHT compared to the No Build Alternative. It should also be noted that the total VHT for all the intersections for each Build Alternative are expected to increase compared to the Existing and Future No Build Alternative, with the highest increases expected during the peak PM hours and lower increases in the AM peak hours. Figure 1 shows a comparison of the total peak AM and PM VHT for each Alternative.

Intersection selection criteria for a microscale analysis is typically based on a Level of Service (“LOS”) D where the project increases traffic volumes by ten percent or greater, or if the intersection operates at LOS E or F and the project degrades conditions at the location. As is shown in Table 1, there are numerous intersections were the LOS is E or F and the project either increases the traffic volumes by ten percent or greater or the project degrades the conditions at the intersection via increase vehicles and delay.

In summary, it can therefore reasonably be concluded the Project Alternatives could increase traffic volumes and delay at most of the 12 intersections evaluated compared to the No Build Alternative, which could result in an increase of CO emissions compared to the No Build Alternative. A quantitative microscale analysis for the worst-case intersections would be conducted during the preparation of the final environmental document to determine if the project would significantly impact air quality and demonstrate compliance with the CO air quality standards.

Table 1 Summer Peak Hour Traffic for Each Alternative



Summer AM Peak Period	Existing				Future No Build				Case 2						Case 3e					
Signalized Intersections	Control Delay	Volume	VHT	LOS	Control Delay	Volume	VHT	LOS	Control Delay	Volume	Volumes Percent Change	VHT	Build - No Build VHT	LOS	Control Delay	Volume	Volumes Percent Change	VHT	Build -No Build VHT	LOS
Forestdale Rd & Rte 6EB Ramps Exit 2	13.7	1790	6.8	A	32.9	2215	20.2	C	41.1	2210	-0.2	25.2	5.0	C	39.6	2205	-0.5	24.3	4.0	C
Forestdale Rd & Rte 6WB Ramps Exit 2	18.2	1435	7.3	A	17.1	1650	7.8	A	20	1615	-2.1	9.0	1.1	A	19.9	1615	-2.1	8.9	1.1	A
Tupper Rd & Rte 6A	17.7	980	4.8	A	18.8	1140	6.0	A	19.8	1235	8.3	6.8	0.8	A	19.9	1210	6.1	6.7	0.7	A
Andy Olivia/Nightingale Pond Rd & Scenic Hwy	8.1	2655	6.0	A	12.8	3115	11.1	B	63	3625	16.4	63.4	52.4	E	62.4	3615	16.1	62.7	51.6	E
Canal Rd & Scenic Hwy/Meetinghouse Ln	31.6	1615	14.2	B	54.3	1960	29.6	C	94.1	2275	16.1	59.5	29.9	E	101.3	2315	18.1	65.1	35.6	E
Trowbridge Rd & Veteran's Way	--	--	--	--	--	--	--	--	14.5	1155	1155.0	4.7	4.7	A	7.3	800	800.0	1.6	1.6	A
Mid-Cape Connector & Sandwich Rd	20.5	2135	12.2	B	23	2565	16.4	B	19.4	2245	-12.5	12.1	-4.3	B	19.8	2280	-11.1	12.5	-3.8	B
Market Basket Dr & Mid-Cape Connector	10.6	1290	3.8	A	19.5	1545	8.4	A	18.9	1585	2.6	8.3	0.0	A	15.4	1640	6.1	7.0	-1.4	A
Scenic Highway & Connector Road to Belmont Roundabout	--	--	--	--	--	--	--	--	191.9	3715	3715.0	198.0	198.0	F	195.8	3705	3705.0	201.5	201.5	F
Bourne Rotary Connector & Sandwich Rd	--	--	--	--	--	--	--	--	0.5	2185	2185.0	0.3	0.3	A	10.4	2525	2525.0	7.3	7.3	A
Route 3EB on-ramp/Church Ln & Scenic Hwy	19.5	2000	10.8	B	21.1	2360	13.8	B	22.2	2970	25.8	18.3	4.5	B	22	3010	27.5	18.4	4.6	B
Old Sandwich Rd & Veteran's Way	--	--	--	--	--	--	--	--	16.1	1090	1090.0	4.9	4.9	A	19.2	1540	1540.0	8.2	8.2	A
Total VHT			65.8				113.3					410.5						424.3		

Summer PM Peak Period	Existing				Future No Build				Case 2						Case 3e					
Signalized Intersections	Control Delay	Volume	VHT	LOS	Control Delay	Volume	VHT	LOS	Control Delay	Volume	Volumes Percent Change	VHT	No Build VHT	LOS	Control Delay	Volume	Volumes Percent Change	VHT	Build -No Build VHT	LOS
Forestdale Rd & Rte 6EB Ramps Exit 2	19.8	2050	11.3	B	260.8	2675	193.8	F	311.6	2700	0.9	233.7	39.9	F	327.7	2710	1.3	246.7	52.9	F
Forestdale Rd & Rte 6WB Ramps Exit 2	25.4	1625	11.5	B	25.4	1885	13.3	B	56.8	1905	1.1	30.1	16.8	C	52.6	1895	0.5	27.7	14.4	C
Tupper Rd & Rte 6A	24.1	1715	11.5	B	55	2125	32.5	C	63.8	2170	2.1	38.5	6.0	D	66.4	2160	1.6	39.8	7.4	D
Andy Olivia/Nightingale Pond Rd & Scenic Hwy	9.7	3060	8.2	A	127.2	4095	144.7	F	229.3	4445	8.5	283.1	138.4	F	219.1	4395	7.3	267.5	122.8	F
Canal Rd & Scenic Hwy/Meetinghouse Ln	102.8	1830	52.3	D	227.2	2670	168.5	F	186.7	2765	3.6	143.4	-25.1	F	249.4	2920	9.4	202.3	33.8	F
Trowbridge Rd & Veteran's Way	--	--	--	--	--	--	--	--	14.6	1170	1170.0	4.7	4.7	A	9.7	695	695.0	1.9	1.9	A
Mid-Cape Connector & Sandwich Rd	26.2	2720	19.8	B	61.4	3360	57.3	E	27.7	3015	-10.3	23.2	-34.1	C	60.3	3145	-6.4	52.7	-4.6	D
Market Basket Dr & Mid-Cape Connector	14.8	1325	5.4	A	39.8	1955	21.6	C	48.9	2085	6.6	28.3	6.7	C	50.7	2250	15.1	31.7	10.1	C
Scenic Highway & Connector Road to Belmont Roundabout	--	--	--	--	--	--	--	--	199.9	4075	4075.0	226.3	226.3	F	184.4	4030	4030.0	206.4	206.4	F
Bourne Rotary Connector & Sandwich Rd	--	--	--	--	--	--	--	--	1.5	2920	2920.0	1.2	1.2	A	27.1	3520	3520.0	26.5	26.5	C
Route 3EB on-ramp/Church Ln & Scenic Hwy	19.1	2420	12.8	B	33.4	3265	30.3	C	52.5	3720	13.9	54.3	24.0	D	51.3	3880	18.8	55.3	25.0	E
Old Sandwich Rd & Veteran's Way	--	--	--	--	--	--	--	--	15.9	1430	1430.0	6.3	6.3	A	10.8	2105	2105.0	6.3	6.3	A
Total VHT			132.8				662.0					1073.1						1164.8		

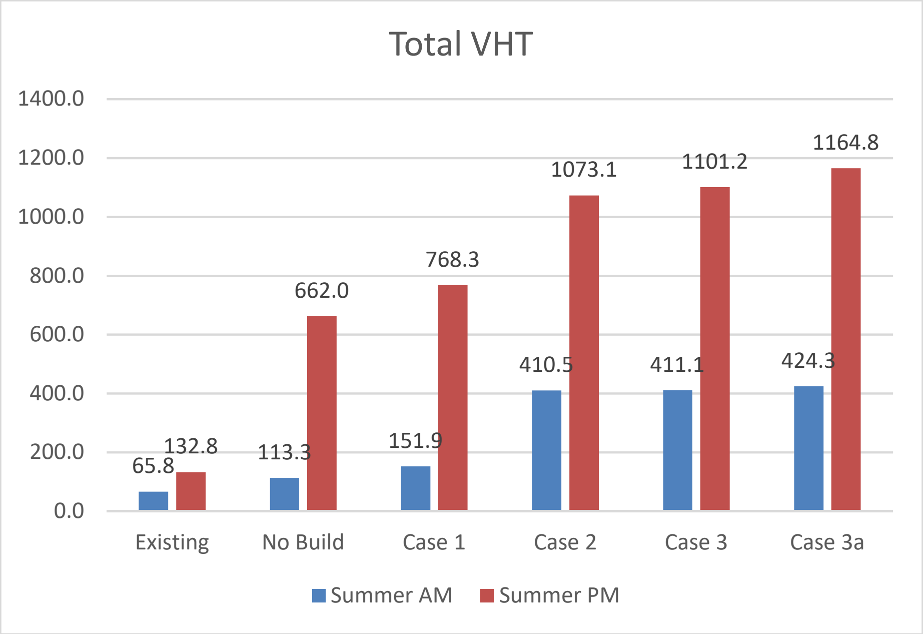


Figure 1 Total Peak Hour VHT for Each Alternative

Mobile Source Air Toxics: The analysis qualitatively evaluated potential impacts from Mobile Source Air Toxics (MSATs) in the Study Area. As the Build Alternatives are not anticipated to add significant capacity to the existing and/or proposed new roadway networks, where design year traffic is projected to be 140,000 to 150,000 annual average traffic (AADT) or greater, the Build Alternatives are best characterized as ones with “Low Potential MSAT Effects” under the 2016 FHWA interim guidance update document[1].

For each alternative, the amount of MSATs emitted would be proportional to the vehicle miles traveled (VMT) which is a function of distance and average daily traffic (ADT), assuming that other variables such as fleet mix are the same for each Alternative. As shown in Table 2, the ADT estimated for each of the Build Alternatives is slightly higher than that for the No Build Alternative, because the additional capacity increases the efficiency of the roadway and attracts rerouted trips from elsewhere in the transportation network. The increase in ADT, which will result in an increase in VMT, would lead to overall higher MSAT emissions in the study area for the Build Alternatives, however as shown in the Table 2, there may be localized areas where VMT would increase and other areas where VMT would decrease. Therefore, it is possible that localized increases and decreases in MSAT emissions may occur for both Build Alternatives. For example, the localized increases in MSAT emissions would likely be most pronounced along the Bourne Bridge, sections of Route 3, sections of Route 6, Route 25, Route 28, and Route 130, the Bourne Bridge Off-ramp to Belmont Circle, and the mid Cape Connector on ramp to Route 6 EB.

MSAT decreases could be expected but not limited to areas along the Sagamore Bridge, portions of Route 3 southbound, portions of Sandwich Road and Adams Street, Belmont Circle, portions of Route 25 and Route 6, portions of Main Street, Herring Pond Onramp, Cranberry Highway On-Ramp, Maple Springs Road Onramp, Route 25 EB Off Ramp, and Scenic Highway Westbound Onramp. The emissions increase may be offset somewhat by lower MSAT emission rates due to increased speeds according to the EPA MOVES2014 model where emissions of all the priority MSATs decrease as speed increases.

---

[1] https://www.fhwa.dot.gov/environMent/air_quality/air_toxics/policy_and_guidance/msat/

Table 2 Summer Adjusted ADT for Each Alternative

ATR Counting Stations	Summer 2014 Summer Adjusted ADT[1]	Future No Build Summer Summer Adjusted ADT	2040 Build - Case 2: ADT Volumes Summer Adjusted ADT	Delta Change - Case 2 vs Future No Build	2040 Build - Case 3A: ADT Volumes Summer Adjusted ADT	Delta Change - Case 3A vs Future No Build
Bourne Bridge	56,500	61,600	69,600	8,000	72,900	11,300
Sagamore Bridge	65,900	93,300	88,700	-4,600	85,300	-8,000
Route 3 SB Off Ramp To Herring Pond Road	4,600	7,900	6,200	-1,700	6,300	-1,600
Route 3 SB Off Ramp To Scenic Highway	3,400	5,000	7,700	2,700	7,700	2,700
Route 3 between Exits 1A and 2	46,500	72,400	79,000	6,600	77,500	5,100
Route 6 Between Exits 1 & 2	72,300	90,600	91,700	1,100	92,400	1,800
Route 25 west of Exit 2	62,900	78,900	84,800	5,900	85,000	6,100
Route 25 east of Exit 2	24,500	26,200	32,800	6,600	33,000	6,800
Route 6A East of Tupper Road	12,400	15,100	14,700	-400	14,400	-700
Route 6 (Scenic Hwy) east of Nightingale Rd	33,600	36,200	47,900	11,700	47,500	11,300
Sandwich Rd East of Bourne Rotary Connector	30,800	33,400	31,100	-2,300	32,200	-1,200
Sandwich Road west of Jillian Drive	31,200	34,600	33,200	-1,400	34,300	-300
Sandwich Road East of Adams Street	11,700	14,900	15,700	800	15,100	200
Adams Street South of Sandwich Road	7,600	11,800	1,100	-10,700	1,000	-10,800
Belmont Circle On Ramp to Bourne Bridge	8,600	11,800	10,300	-1,500	10,200	-1,600
Belmont Circle On Ramp to Route 25 WB	12,100	12,200	3,400	-8,800	3,400	-8,800
Bourne Bridge Off Ramp to Belmont Circle	7,200	7,100	11,700	4,600	12,600	5,500
Buzzards Bay Bypass	7,900	8,800	8,500	-300	8,600	-200
Cranberry Highway On Ramp to Route 6 WB	6,500	11,100	7,000	-4,100	6,100	-5,000
Glen Charlie Road On Ramp to Route 25 EB	2,200	2,000	2,400	400	2,500	500
Main Street West of Perry Avenue	25,600	28,500	26,800	-1,700	26,800	-1,700
Mid-Cape Connector South of Sandwich Rd	19,100	28,500	30,100	1,600	32,600	4,100
Route 151 On Ramp to Route 28 NB		5500	6800	1,300	6800	1,300
Route 151 On Ramp to Route 28 SB		1,600	2,400	800	2,300	700
Route 28 NB Off Ramp to Route 151		600	1500	900	1500	900
Route 28 SB Off Ramp to Route 151		5500	7300	1,800	7300	1,800
Route 25 EB Off Ramp to Belmont Circle	9,000	11,200	13,500	2,300	11,900	700
Route 25 EB Off Ramp to Maple Springs Rd	7,300	14,800	11,300	-3,500	11,000	-3,800
Route 3 NB Off Ramp to Herring Pond Road	1,800	3,100	3,700	600	3,700	600
Route 6 EB Off Ramp to Mid-Cape Connector	5,900	8,600	8,600	0	8,100	-500
Route 6 EB Off Ramp to Quaker Meeting House Rd	1,300	1,700	1,700	0	1,800	100
Route 6 EB Off Ramp to Route 130	7,000	15,700	19,600	3,900	20,000	4,300
Route 6 WB Off Ramp to Cranberry Hwy	5,500	3,800	4,400	600	4,500	700
Route 6 WB Off Ramp to Meetinghouse Lane EB	4,700	4,500	4,600	100	4,600	100
Route 6 WB Off Ramp to Quaker Meetinghouse Rd	1,000	2,300	1,600	-700	1,600	-700
Route 6 WB Off Ramp to Route 130	2,200	2,000	2,000	0	1,900	-100
Route 6 WB Off Ramp to Scenic Hwy WB	11,800	13,400	13,800	400	13,800	400
Herring Pond Road On Ramp to Route 3 NB	4,400	5,500	5,700	200	5,600	100
Herring Pond Road On Ramp to Route 3 SB	2,500	7,800	6,700	-1,100	6,700	-1,100
Maple Springs Rd On Ramp to Route 25 WB	6,900	11,000	8,900	-2,100	9,000	-2,000
Mid Cape Connector On Ramp to Route 6 EB	12,500	12,500	13,500	1,000	16,000	3,500
Quaker Meeting House Rd On Ramp to 6 EB	2,700	4,400	3,900	-500	3,800	-600
Quaker Meeting House Rd On Ramp to Route 6 WB	1,000	1,100	1,600	500	1,600	500
Route 130 North of Route 6	12,200	12,500	11,300	-1,200	11,400	-1,100
Route 130 On Ramp to Route 6 EB	2300	1800	1400	-400	1400	-400
Route 130 South of Route 6	24,500	28,600	32,300	3,700	32,200	3,600
Route 130 On Ramp to Route 6 WB	9,400	12,300	15,300	3,000	15,100	2,800
Scenic Hwy EB On Ramp to Sagamore Bridge	9400	11100	9900	-1,200	8100	-3,000
Scenic Hwy WB On Ramp to Sagamore Bridge	3600	6700	4000	-2,700	3800	-2,900
State Road North of Ramp to Route 3 NB	5700	8200	8300	100	8400	200
Trowbridge Road West of Veterans Way	7300	12000	10100	-1,900	4400	-7,600
NEW Belmont Circle On Ramp to Route 25 WB				0		0
	Totals	921,700	940,100	18,400	935,700	14,000
	Change		1.99		1.52	

Regardless of the option chosen, emissions will likely be lower than present levels in the design year as a result of EPA's national control programs that are projected to reduce annual MSAT emissions by over 90 percent 2010 and 2050. Local conditions may differ from these national projections in terms of fleet mix and turnover, VMT growth rates, and local control measures. However, the magnitude of the EPA-projected reductions is so great (even after accounting for VMT growth) that MSAT emissions in the study area are likely to be lower in the future in nearly all cases.

Mesoscale Analysis: A mesoscale analysis is typically performed to calculate the potential regional air quality impact of the project using as a measure the total daily emissions of volatile organic compounds (VOCs) and oxides of nitrogen (NOx) within the project area. Calculations are typically performed to compare area-wide emissions for future Build scenarios with the Existing and future No-Build conditions. Typically, emission factors for each pollutant are generated for each roadway link using the EPA emission models based on vehicle miles traveled, vehicle speeds and other roadway data relative to the Project. Table 2 shows the summer adjusted ADT for the Existing, future No Build and Build Alternatives affected links. As discussed above in the MSAT section, Summer ADT is expected to slightly increase with the Build Alternatives compared to the future No-Build Alternative. As a result, overall emissions of VOCs and NOx could also slightly increase with the Build Alternatives. Similar to the MSAT analysis, there are localized areas where increases and decreases could occur and some increases may be mitigated due to increased vehicle speeds. Given the relatively small expected ADT increase associated with the Build Alternatives of approximately 2.0 percent and 1.5 percent relative to the total VMT's in the region, it is unlikely that this portion of the project would result in a substantial change in emissions or any subsequent direct or indirect impacts to the mesoscale analysis. A quantitative mesoscale analysis will be conducted during the preparation of the final environmental document, once the number of alternatives has been narrowed, and the alternatives selected for study have been refined.

Greenhouse Gases: The transportation system is a critical component of the Commonwealth of Massachusetts' infrastructure and contributes over one third of the Bay State's greenhouse gas (GHG) emissions. The Massachusetts Executive Office of Energy and Environmental Affairs (EOEEA), in consultation with other state agencies and the public, released the Massachusetts Clean Energy and Climate Plan for 2020. This implementation plan establishes targets for overall, statewide GHG emissions:

- By 2020, 20 percent reduction below statewide 1990 GHG emission levels;
- By 2050, 80 percent reduction below statewide 1990 GHG emission levels

In 2010, the Massachusetts Department of Transportation (MassDOT) responded to these challenges by launching the GreenDOT Policy. GreenDOT was developed to reduce GHG emissions, improving public health, and leading on environmental stewardship. In addition, Executive Orders 484 *Leading by Example* and 515 *Environmental Purchasing Policy*, require state agencies to invest public resources in ways that support environmental sustainability by conserving energy and water, implementing efficiency measures, and producing or purchasing renewable energy. Taken together, these acts and policies form the foundation for the GreenDOT Policy. The GreenDOT Policy Directive, released in June 2010, set forth the primary goals of reducing GHG emissions; promoting the healthy transportation modes of walking, bicycling, and public transit; and supporting smart growth development. The Cape Cod Regional Transportation Plan (RTP) reflects the vision of the GreenDOT Policy with the Multimodal Options/Healthy Transportation Goal, including a *Performance Measure* reflecting the state Mode Shift Goal. The Cape Cod Commission conducted a GHG analysis as part of the 2016 Regional Transportation Plan[2]. Anticipated GHG impacts from nine specific regional target projects were conducted. Two of those projects, 1) Belmont Circle/Route 25 Ramp Improvements and 2) Route 6 Exit 1C reconfiguration were included in the GHG analysis. The results of the anticipated GHG impacts from these two projects were documented as "quantified decrease in emissions from traffic operation improvement-to be verified by statewide modeling". Similarly, any increase or decreases in GHG emissions for the Build

---

[2] http://www.capecodcommission.org/resources/transportation/rtp/2016/FinalReport/Appendices/RTP%20Appendix%20N%20-%20Greenhouse%20Gas%20Analysis%20(Endorsed%207-20-15).pdf

Alternatives would need to be quantified in the final environmental document to account for VMT and vehicle speeds for the Build Alternatives compared to the No Build.

hmmh

This Page Intentionally Left Blank

CAPE COD CANAL HIGHWAY BRIDGES
BOURNE, MASSACHUSETTS

MAJOR REHABILITATION EVALUATION REPORT

APPENDIX F
PUBLIC INVOLVEMENT

This Page Intentionally Left Blank

NEWS RELEASE

U.S. ARMY CORPS OF ENGINEERS

BUILDING STRONG®

For Immediate Release:
Nov. 9, 2018
Release No. MA 2018-095

Contact:
Tim Dugan, 978-318-8264
cenae-pa@usace.army.mil

Corps of Engineers to hold five public information meetings in December on Cape Cod Canal Bridge MRER Study

CONCORD, Mass. – The U.S. Army Corps of Engineers, New England District will hold five public information meetings in early to mid-December 2018 in and around Cape Cod to discuss the future of the Cape Cod Canal highway bridges spanning the Cape Cod Canal in Bourne, Massachusetts. Corps public information meetings are scheduled for Dec. 4 in Bourne, Dec. 5 in Plymouth, Dec. 6 in Nantucket, Dec. 11 in Martha's Vineyard and Dec. 12 in Hyannis.

The Corps is conducting a multiyear Major Rehabilitation Evaluation study of the Bourne and Sagamore highway bridges to determine whether major rehabilitation or replacement of either or both bridges will provide the most reliable, fiscally responsible solution for the future. The existing bridges were constructed 83 years ago and require increasingly more frequent maintenance, which is costly and causes significant impact to traffic crossing the Cape Cod Canal.

The study will result in a Major Rehabilitation Evaluation Report (MRER) evaluating the risk and reliability of the structures as well as the economic impacts/benefits of a number of alternatives including continuation of routine maintenance, major rehabilitation, and bridge replacement. The MRER is comprised of four elements: 1) structural engineering analysis of the bridges; 2) cost estimates for rehabilitation and/or replacement alternatives; 3) economic benefits of the alternatives; and 4) environmental effects of the alternatives.

As part of National Environmental Policy Act (NEPA) compliance, the Corps is seeking public input and will coordinate with appropriate state and Federal agencies and federally recognized Tribes to fully evaluate the alternatives.

During the public information meetings, the Corps will provide an overview of the MRER study, and the public and other stakeholders will have an opportunity to provide comments related to the study.

Registration will start at 6 p.m. There will be an open house from 6 – 6:30 p.m. with information posters and Corps staff on hand to answer questions about the MRER. A project overview presentation will begin at 6:30 p.m., followed by the opportunity for public comment concluding with all comments provided, or building closure, whichever comes first.

Public comments will be taken throughout the study process and a project website and email address to submit comments will be provided at the meeting.

The Corps public information meetings are scheduled for the following dates and locations:

- Tuesday, Dec. 4, 2018 in the Bourne High School auditorium, 75 Waterhouse Road in Bourne, Mass.

- Wednesday, Dec. 5, 2018 in the Plymouth South High School, Performing Arts Center, 490 Long Pond Road in Plymouth, Mass.

- Thursday, Dec. 6, 2018 in the Nantucket High School auditorium, 10 Surfside Road in Nantucket, Mass.

- Tuesday, Dec. 11, 2018 in the Martha's Vineyard High School Performing Arts Center, 100 Edgartown-Vineyard Haven Road in Oak Bluffs, Martha’s Vineyard, Mass.

- Wednesday, Dec. 12, 2018 in the Barnstable High School Performing Arts Center, 744 West Main Street in Hyannis, Mass.

NEWS RELEASE

U.S. ARMY CORPS OF ENGINEERS

BUILDING STRONG®

For Immediate Release:
Dec. 27, 2018
Release No. MA 2018-115

Contact:
Tim Dugan, 978-318-8264
cenae-pa@usace.army.mil

Public comments on bridge study can be submitted on-line

Corps of Engineers working with agencies, public to complete Draft Cape Cod Canal MRER bridge study

CONCORD, Mass. – The U.S. Army Corps of Engineers, New England District recently held five public information meetings on the Cape, the South Shore and the Islands on the future of the Cape Cod Canal highway bridges spanning the Cape Cod Canal in Bourne, Massachusetts, and is now working to complete the draft bridge study and draft environmental assessment.

The Corps is conducting a multiyear Major Rehabilitation Evaluation study of the Bourne and Sagamore highway bridges to determine whether major rehabilitation or replacement of either or both bridges will provide the most reliable, fiscally responsible solution for the future. The existing bridges were constructed 83 years ago and require increasingly more frequent maintenance, which is costly and causes significant impact to traffic crossing the Cape Cod Canal.

More information on the Corps bridge study, including the presentation from the public information meetings, is available on the website at www.CapeCodCanalBridgesStudy.com.

The bridge study will result in a Major Rehabilitation Evaluation Report (MRER) evaluating the risk and reliability of the structures as well as the economic impacts/benefits of a number of alternatives including continuation of routine maintenance, major rehabilitation, and bridge replacement. The MRER is comprised of four elements: 1) structural engineering analysis of the bridges; 2) cost estimates for rehabilitation and/or replacement alternatives; 3) economic benefits of the alternatives; and 4) environmental effects of the alternatives.

The initial Corps alternatives include: **1)** without project plan (no action, continue to repair bridges as needed); **2)** major rehabilitation of each bridge as they currently exist and maintenance of the rehabbed bridges in the future; **3)** replacement of each bridge with a new structure built to current authorization of 4 lanes, 2 lanes each way brought up to modern highway standards with appropriate bike/pedestrian access; and **4)** replacement of each bridge with a new structure built to include the 4 authorized lanes and 2 auxiliary lanes designed as acceleration/deceleration lanes (entrance/exit) and built to modern day highway standards with appropriate bike/pedestrian access.

During a major rehabilitation the major components needing repairs would be reconditioned or replaced. Each major rehab would be expected to take approximately 3 ½ years to complete and would be done off-season from the latter part of October through mid-May, as much as feasible. These fixes would maintain bridge performance, but would result in a number of traffic delays during the rehab process.

– more –

Corps working to complete Draft Canal MRER bridge study

At the public information meetings in December, the Corps received additional suggestions from the public on bridge alternatives that they thought should be considered. These suggestions will be reviewed as part of the MRER study and NEPA process.

The MRER will be a decision document that compares a number of alternatives to determine the most fiscally responsible plan for the future of the two bridges that is also environmentally acceptable. The MRER will not result in a final bridge design for any replacement, nor initiate construction activities, nor guarantee future funding.

As part of National Environmental Policy Act (NEPA) compliance, the Corps is seeking public input and in the coming weeks and months will be reaching out to Federal and state agencies and Federally-recognized Tribes to continue the environmental review process to ensure all appropriate topics are covered within the Draft MRER and Draft Environmental Assessment.

Public comments can be submitted online at: www.CapeCodCanalBridgesStudy.com. Written comments can be submitted to: U.S. Army Corps of Engineers, Attn: Cape Cod Bridges Study NEPA Coordinator, 696 Virginia Road, Concord, MA 01742-2751.

The Corps is responsible for the Bourne and Sagamore bridges from abutment to abutment. The Massachusetts Department of Transportation (MassDOT) is responsible for approach roads and adjacent infrastructure. MassDOT is completing its own regional multi-modal transportation study of adjacent infrastructure improvements that are designed to ease traffic congestion.

The Corps is developing the Draft MRER and Draft Environmental Assessment on the highway bridges and anticipates the documents will be ready for public review and comment in the summer of 2019. The release of these documents will be followed by public meetings and a final comment period. After that review and public comment the Corps will work to complete the report and anticipates the Final MRER and Final Environmental Assessment will be completed in the winter of 2019/2020.

MAJOR REHABILITATION EVALUATION STUDY
Cape Cod Canal Bridges

US Army Corps
of Engineers

How to Participate

What is the purpose of this meeting?

The U.S. Army Corps of Engineers (USACE) is preparing an Environmental Assessment for the Cape Cod Canal Bridges Major Rehabilitation Evaluation Report (MRER).

The USACE is conducting a multiyear study of the bridges to determine whether major rehabilitation or replacement of either or both bridges will provide the most reliable, fiscally responsible solution for the future. The existing bridges were constructed 83 years ago and require frequent maintenance, which is costly and causes significant impact to traffic crossing the Cape Cod Canal.

An Environmental Assessment (EA) will be conducted as required by the National Environmental Policy Act of 1969 (NEPA). Under NEPA, Federal agencies must consider the impacts of a proposed project or action on the natural and human environment and take this information into account in their decision-making.

What is an Environmental Assessment?

Proposed actions that are not anticipated to result in significant impacts are analyzed through an EA rather than a more detailed Environmental Impact Statement (EIS). An EA analyzes the potential impacts of an action in sufficient detail to determine whether there are likely to be significant effects. A Finding of No Significant Impact (FONSI) is issued if the agency determines the proposed action will not have a significant impact to the human environment. The proposing agency may proceed with implementing the action once all analyses have been completed and potential effects thoroughly considered.

How is an EA prepared?

A typical Environmental Assessment involves the following steps:

1. **Public Involvement:** The USACE consults with agencies, federally recognized Tribes, interested groups, and the public to ensure that all important issues are considered.
2. **Preparation of the Draft EA:** A Draft EA is prepared by a team of environmental professionals to address all identified concerns. It describes the proposed action, the alternatives being considered, and the potential impacts of these alternatives on the environment both natural (air, water, vegetation, wildlife, etc.) and human-made (land use, traffic and transportation, noise, community resources, etc).
3. **Review of the Draft EA:** Once complete, the Draft EA is made available for review and comment. The USACE will hold public meetings when the Draft EA is released.
4. **Preparation of the Final EA:** After comments are received and analyzed, the USACE will prepare a Final EA. The Final EA incorporates and addresses the comments on the Draft.
5. **Publication of the Final EA and Finding of No Significant Impact (FONSI):** If the USACE determines the proposed action will not have a significant impact USACE will prepare a FONSI. The FONSI document is the document in which the USACE announces and explains its decision after having considered the findings of the EA and the comments received. If the USACE determines the action will have a significant impact on the human environment an EIS will be prepared.

What will the USACE do with my comments?

Comments will be collected, reviewed, and considered during drafting of the EA. They will be taken into consideration in making the decision as to whether issuing a FONSI is warranted. Although the USACE will not respond to each comment individually, both the Draft EA and the Final EA will be made available to the public.

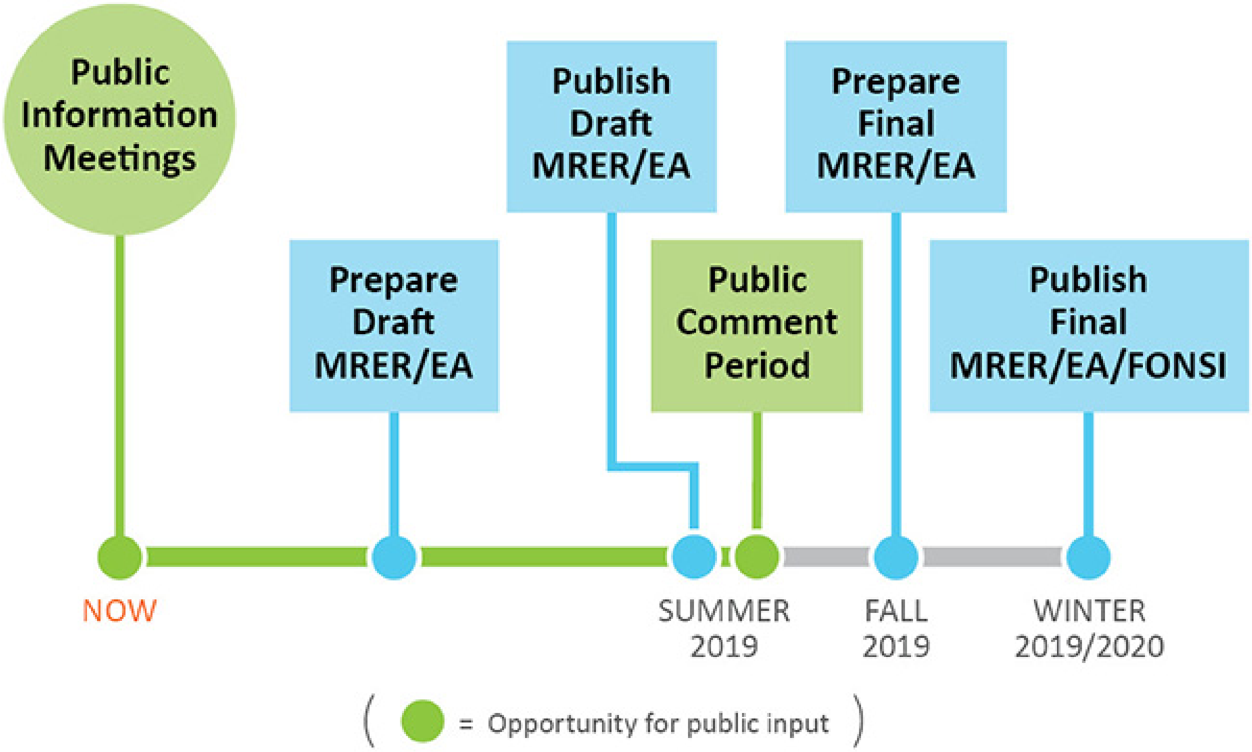
Is this meeting my only chance to comment?

There are multiple ways to submit comments, as identified in the box on this page. Another series of public meetings will be held following publication of the Draft MRER/EA. All comments received will become part of the Administrative Record and will be published in the final EA.

Ways to Comment

- Voice your comment at today's meeting where a court reporter will record your comment
- Provide written comments at today's meeting
- **Submit comments online via the project website:** **www.CapeCodCanalBridgesStudy.com**
- Mail written comments to:
  U.S. Army Corps of Engineers
  Attn: Cape Cod Bridges Study NEPA Coordinator
  696 Virginia Road
  Concord, MA 01742

Environmental Assessment Timeline



To learn more about the study, please visit the project website:
www.CapeCodCanalBridgesStudy.com

MAJOR REHABILITATION EVALUATION STUDY
Cape Cod Canal Bridges

US Army Corps of Engineers

Project Overview

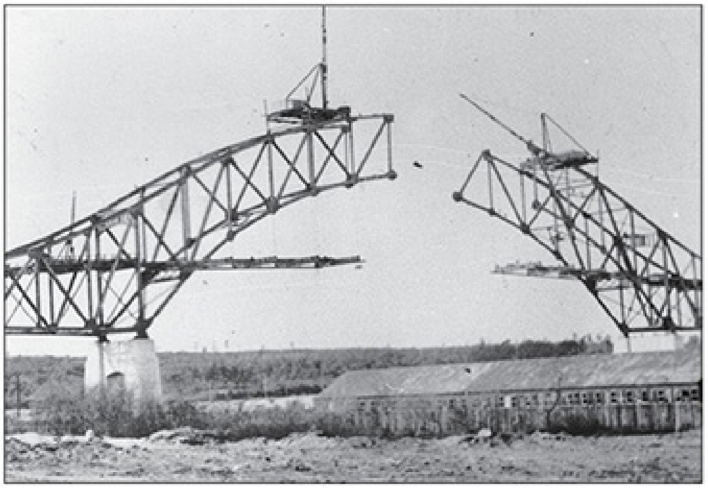
The U.S. Army Corps of Engineers (USACE), New England District, is conducting a multi-year Major Rehabilitation Evaluation Study of the Bourne and Sagamore highway bridges spanning the Cape Cod Canal to evaluate the current conditions of the bridges and what alternatives are feasible for the future.

The existing bridges were constructed more than 83 years ago and require frequent maintenance, which is costly and causes significant impacts to traffic crossing the Cape Cod Canal. The Study will result in a Major Rehabilitation Evaluation Report (MRER) and determine whether standard operation and maintenance, major rehabilitation, or replacement of both bridges will provide the most reliable, fiscally responsible solution for the future. The MRER will provide the basis of decision-making for USACE and Congress on the most cost-effective, safe alternative for critical public transportation access across Cape Cod Canal for the next several decades.

As part of the MRER, the USACE will develop an Environmental Assessment (EA) under the National Environmental Policy Act (NEPA) to examine the potential effects associated with the alternatives examined within the MRER, and allow for public involvement in the evaluation process.

History of the Bridges

On March 31, 1928, under direction from Congress and through authorization of the River and Harbors Act of 1927, the USACE assumed control of the Cape Cod Canal previously constructed by wealthy financier August Belmont, Jr. Along with maintaining the Canal, this authorization directed the USACE to build, operate, and maintain two high-span highway bridges to replace smaller cantilever bridges which had previously made navigating the canal difficult and unpopular with the maritime community. After listening to the concerns of waterway users and the public, the USACE constructed new bridges, the Bourne and Sagamore, from 1933 to 1935, to provide two lanes of vehicle access (toll free) each way including pedestrian access. The highway bridges, and the companion Railroad Bridge constructed during the same era, provide the only means of access to the towns on Cape Cod and Islands. Approximately 215,000 residents and 5 million visitors use these bridges each year.



The USACE performs regular bridge inspections every 24 months, and maintains a 5-year operation and maintenance (O&M) plan to identify and schedule regular maintenance activities. The last major rehabilitation of the bridges was completed in the early 1980s. Since then, numerous O&M activities have been performed; some of these requiring lane closures dependent on the nature of the maintenance effort. Most recently these included steel repairs on the Bourne Bridge in 2012, joint replacement on the Sagamore Bridge in the spring of 2018, and upcoming effort to replace joints on the Bourne Bridge during the spring of 2019.

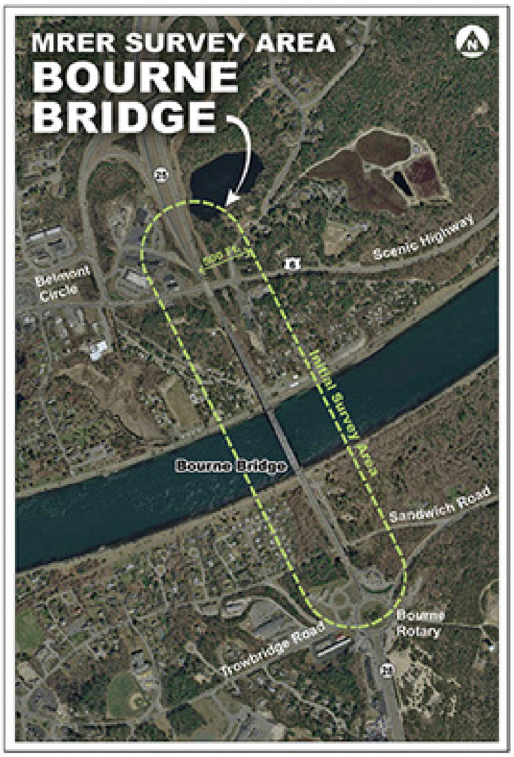
While the USACE will continue its rigorous inspection and maintenance schedule to keep the bridges operating as intended, construction costs and durations of these maintenance activities are anticipated to be significant. This is why the USACE is conducting the MRER Study.

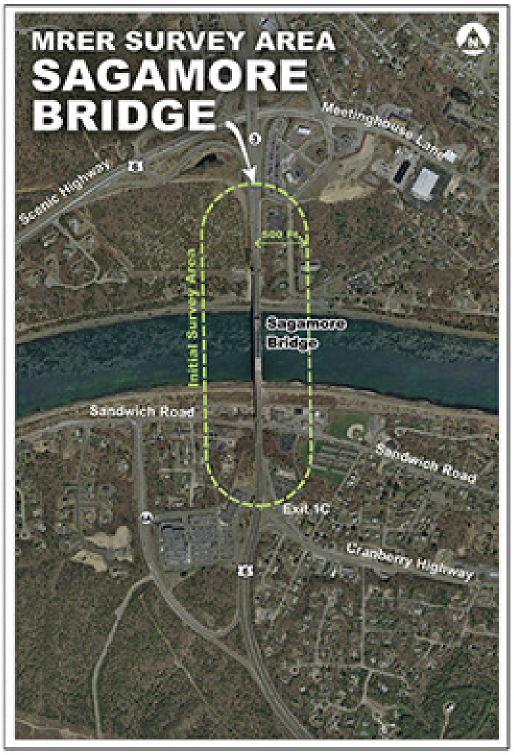
Major Rehabilitation Study

To better understand the condition of its Civil Works projects the USACE completes a MRER whenever infrastructure maintenance construction costs are expected to exceed $20 million and take more than 2 years of construction to complete. The MRER is based on four pillars of evaluation: a structural engineering risk and reliability analysis of the current structures, cost engineering, economic analysis, and environmental evaluation of all feasible alternatives. A MRER identifies operational and potential reliability issues, as well as opportunities for efficiency improvement, over a 50-year period of analysis.

The MRER will compare the "without project" condition to all other alternatives. The "without project" condition refers to a baseline of continued regular inspections and standard maintenance construction on the bridges.

The MRER is the basis for USACE and Congressional decision-making between completing major rehabilitation or construction of new structures. While the MRER encompasses all necessary permitting of the selected plan, it will not result in a full design and construction. Additional efforts will be undertaken at the conclusion of the MRER to derive any additional Congressional authorization necessary leading to a full design and construction of the selected path forward.





Partnerships

The USACE is working with Federal and State partners, and local stakeholder groups to get technical and regional input for development of the MRER. Specifically, the USACE has entered into a Memorandum of Understanding with the Massachusetts Department of Transportation to continue sharing information and collaborative decision-making regarding the Bourne and Sagamore Bridges and future Cape Cod Canal regional transportation infrastructure alternatives into the future.

In addition, the USACE is closely coordinating with the Federal Highway Administration, U.S. Coast Guard, the Environmental Protection Agency, National Oceanic and Atmospheric Administration's National Marine Fisheries Service, federally recognized Tribes, a number of regulatory agencies of the Commonwealth of Massachusetts, and the more than 20 towns in the area to inform these stakeholders on the MRER process.

To learn more about the study, please visit the project website:
www.CapeCodCanalBridgesStudy.com

Welcome

PUBLIC INFORMATION MEETINGS | DECEMBER 2018

How to submit your comments:

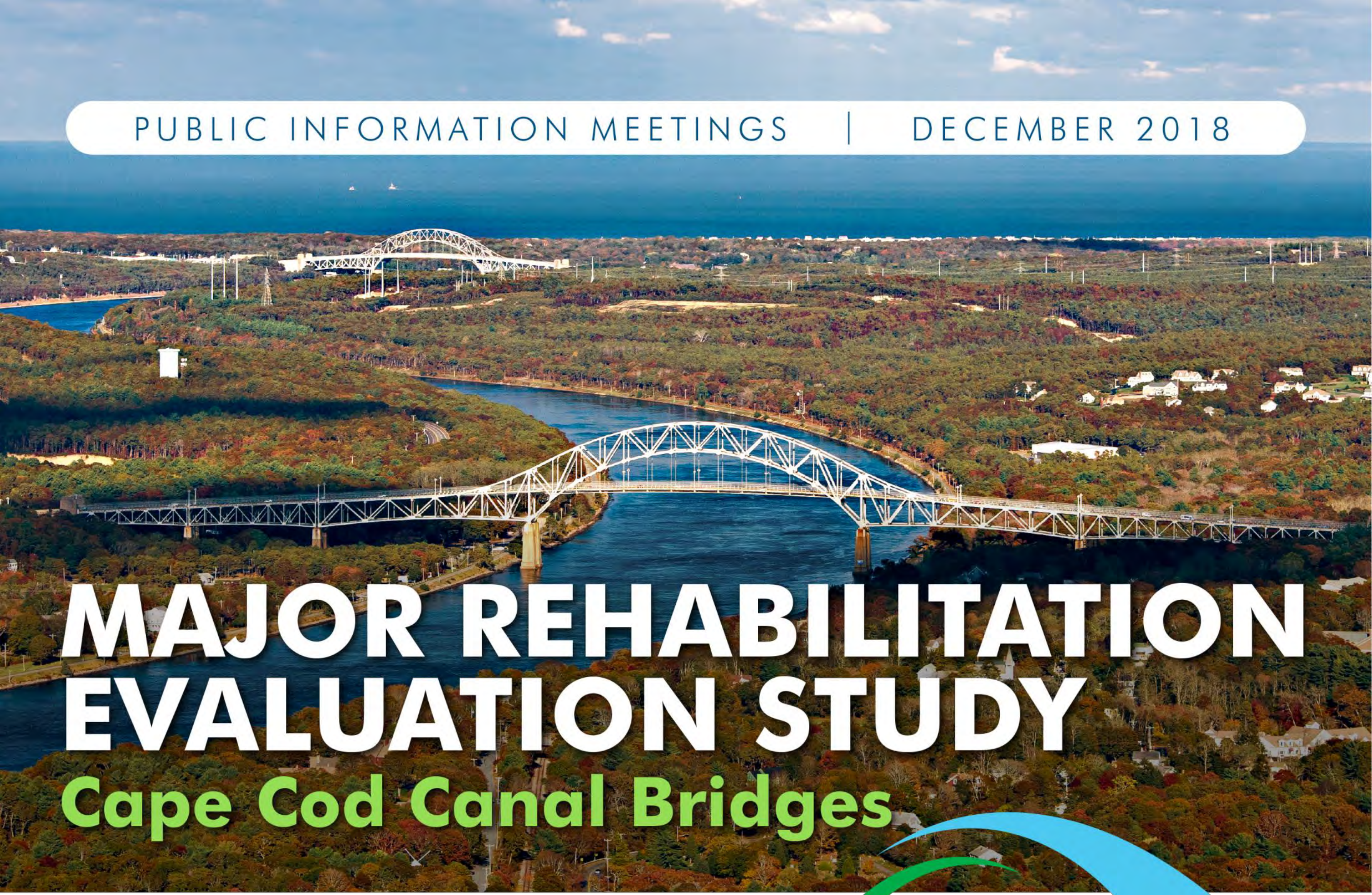
- Voice your comments tonight – sign up to speak at the registration desk
- Submit comments online: www.CapeCodCanalBridgesStudy.com
- Mail your comments by Comment Card also found at the registration desk

MAJOR REHABILITATION EVALUATION STUDY

Cape Cod Canal Bridges

US Army Corps of Engineers ®

U.S.ARMY



PUBLIC INFORMATION MEETINGS | DECEMBER 2018

MAJOR REHABILITATION EVALUATION STUDY

Cape Cod Canal Bridges

US Army Corps of Engineers®

U.S.ARMY

Tonight’s Agenda

Authorization and History of Cape Cod Canal and Bridges

—

Existing Bridge Conditions

—

Major Rehabilitation Evaluation Study and Alternatives

—

NEPA Process / Timeline

—

Partnerships

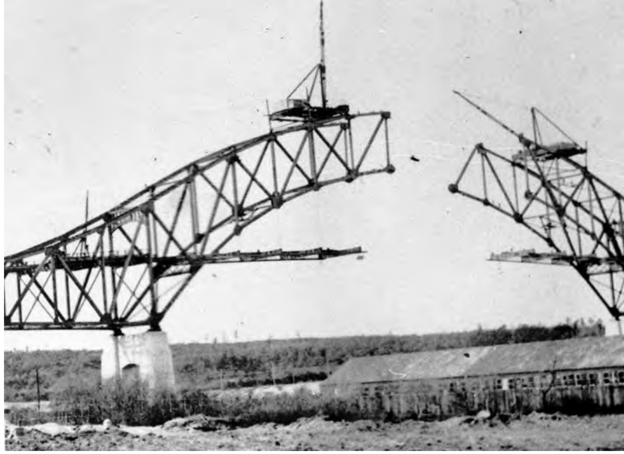
—

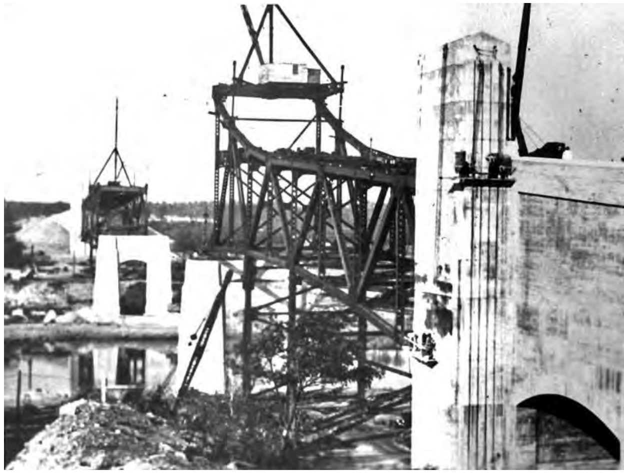
How You Can Participate

Federal Authorization of the Cape Cod Canal

- **Rivers and Harbors Act of 1927**
- **US Army Corps takes possession to operate & maintain March 31, 1928**
- **Federal Navigation Project is composed of:**
  - Channel linking Buzzards Bay to Cape Cod Bay
  - Access areas surrounding the canal
  - Railroad Bridge
  - Bourne and Sagamore highway bridges

History of Cape Cod Canal Bridges





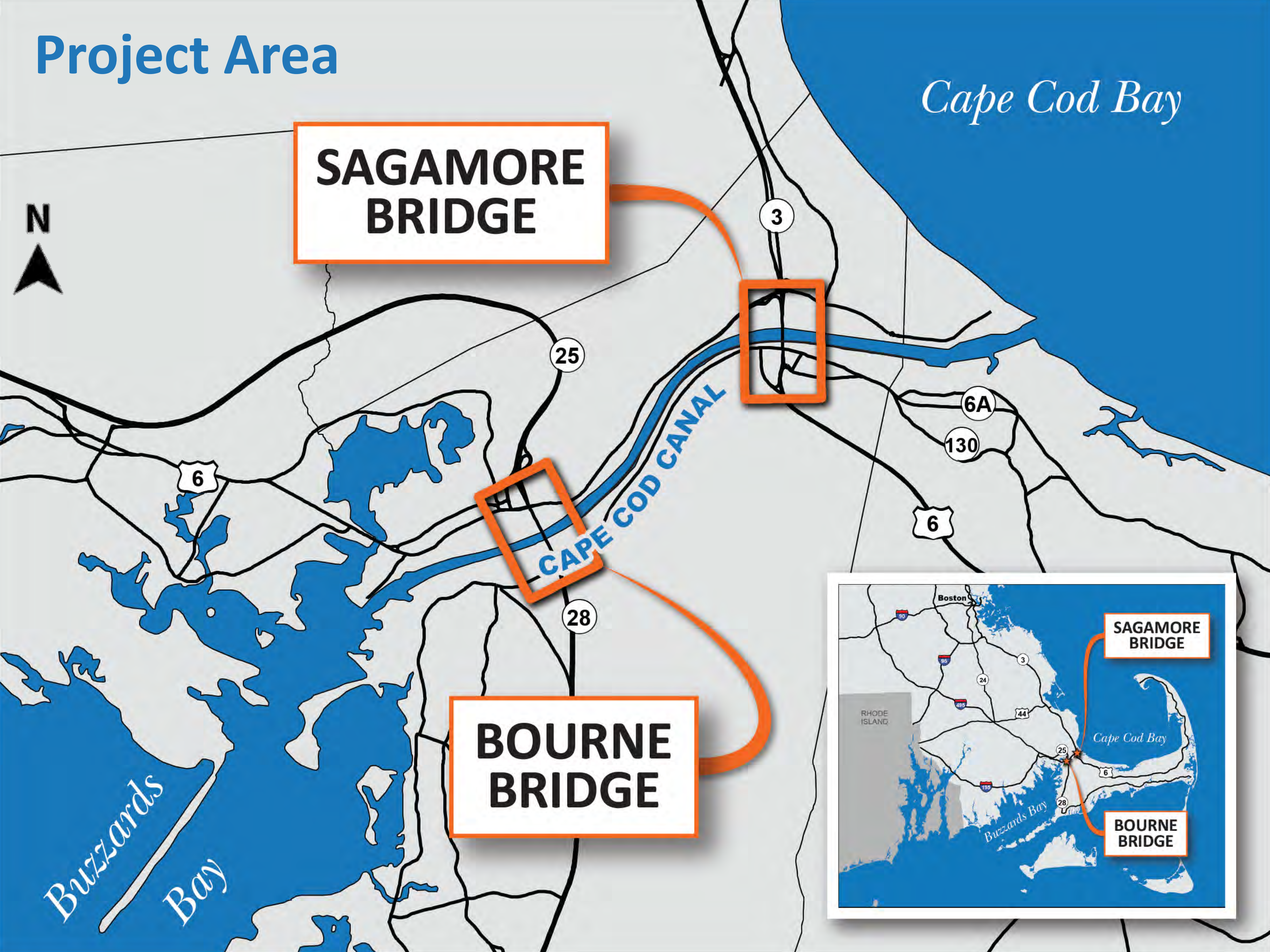
Designed and built by the US Army Corps of Engineers

Built between 1933 and 1935

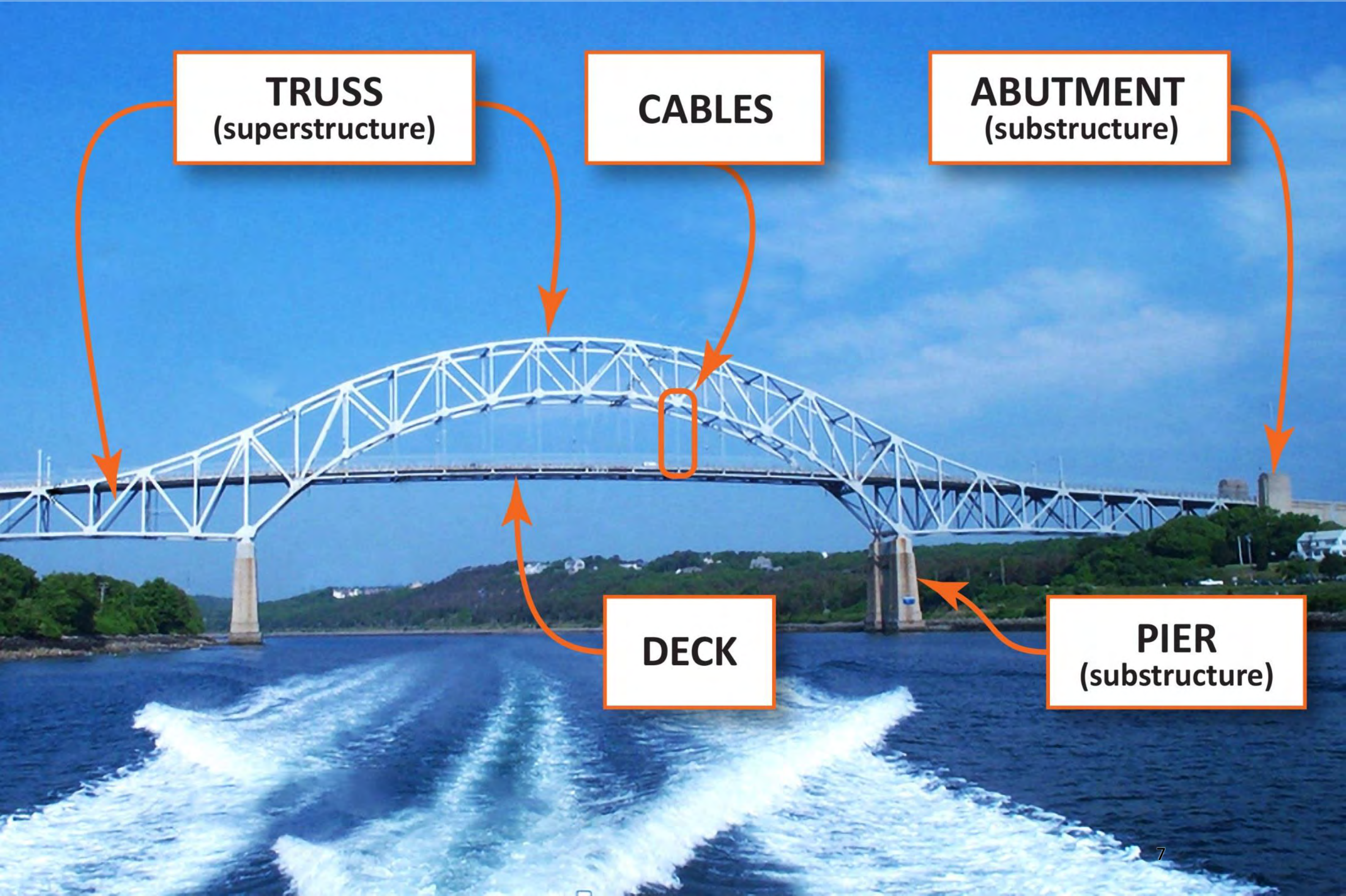
Approved bridge design funded by Congress:

- Two highway bridges providing access to/from the Cape
- 4 lanes total per bridge; 2 lanes each way
- Abutment to abutment
- No tolls

Project Area



Components of a Truss Bridge



TRUSS
(superstructure)

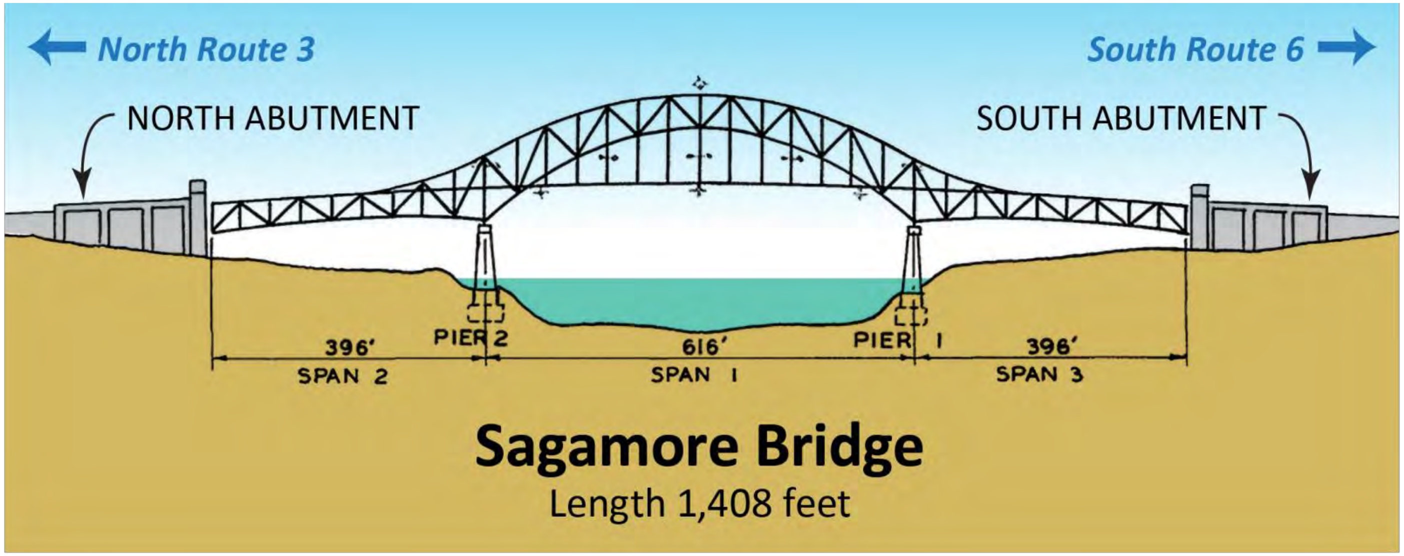
CABLES

ABUTMENT
(substructure)

DECK

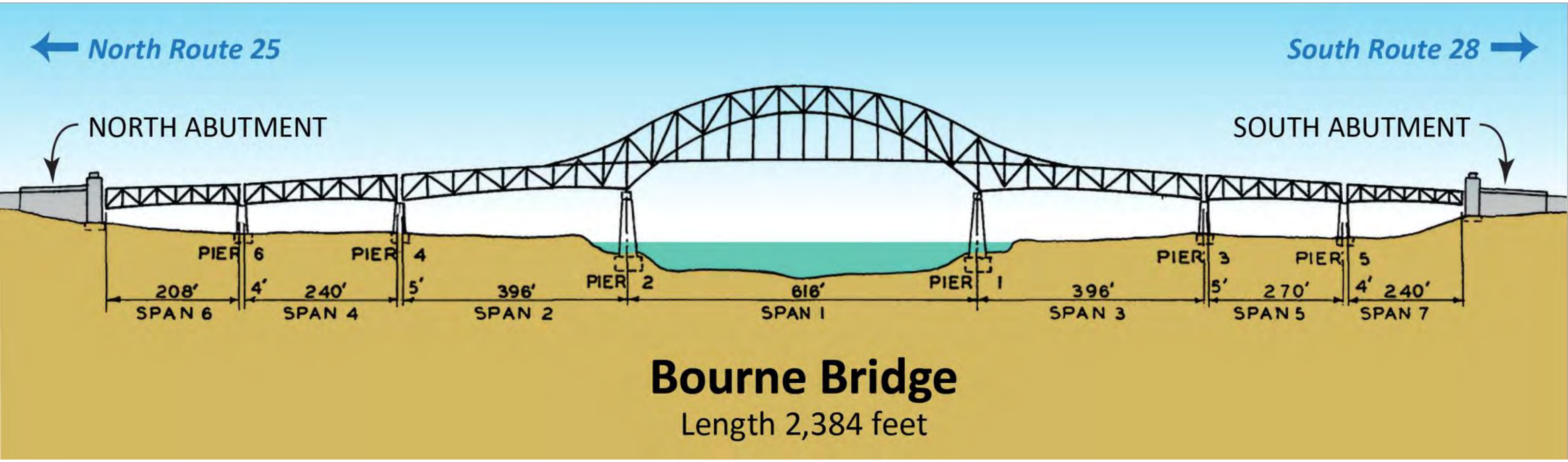
PIER
(substructure)

Canal Bridges Truss Construction



Sagamore Bridge

Length 1,408 feet



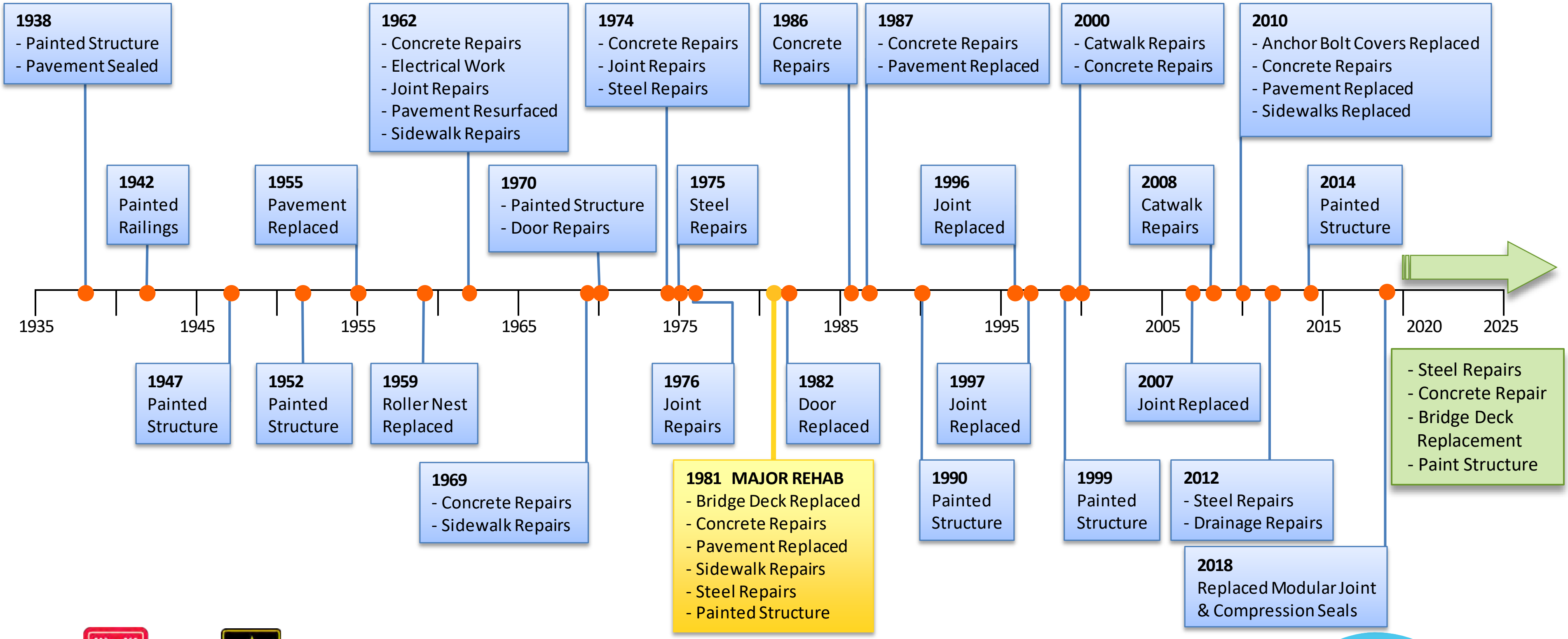
Bourne Bridge

Length 2,384 feet

Bridge Operation & Maintenance (O&M)

- Maintenance is performed under a 5-year plan
- Routine maintenance and emergency repairs increasing in frequency

MAINTENANCE ACTIVITIES FOR SAGAMORE BRIDGE



1938
- Painted Structure
- Pavement Sealed

1942
Painted Railings

1947
Painted Structure

1952
Painted Structure

1955
Pavement Replaced

1959
Roller Nest Replaced

1962
- Concrete Repairs
- Electrical Work
- Joint Repairs
- Pavement Resurfaced
- Sidewalk Repairs

1969
- Concrete Repairs
- Sidewalk Repairs

1970
- Painted Structure
- Door Repairs

1974
- Concrete Repairs
- Joint Repairs
- Steel Repairs

1975
Steel Repairs

1976
Joint Repairs

1981 MAJOR REHAB
- Bridge Deck Replaced
- Concrete Repairs
- Pavement Replaced
- Sidewalk Repairs
- Steel Repairs
- Painted Structure

1982
Door Replaced

1986
Concrete Repairs

1987
- Concrete Repairs
- Pavement Replaced

1990
Painted Structure

1996
Joint Replaced

1997
Joint Replaced

1999
Painted Structure

2000
- Catwalk Repairs
- Concrete Repairs

2007
Joint Replaced

2008
Catwalk Repairs

2010
- Anchor Bolt Covers Replaced
- Concrete Repairs
- Pavement Replaced
- Sidewalks Replaced

2012
- Steel Repairs
- Drainage Repairs

2014
Painted Structure

2018
Replaced Modular Joint & Compression Seals

- Steel Repairs
- Concrete Repair
- Bridge Deck Replacement
- Paint Structure

Bridge O&M

- Rigorous inspections every 24 months
- O&M performed regularly

CAPE COD TIMES

USACE

BOSTON GLOBE

Current Conditions

Structures require increasing maintenance

- Considered in overall “Fair” and Safe condition by National Bridge Inspection Standards
- Portions of bridges more in need of significant repair than others
- Extensive, Costly repairs anticipated by **2025**

Structures are “functionally obsolete”

- Narrow lane / No median
- Shoulders non-existent
- Inadequate pedestrian / bicycle access

What is the Major Rehabilitation Evaluation Study?

- Authorized in Water Resource Development Act (WRDA) of 1992, Sec 205 (modified by WRDA 14) for all Civil Works
- Required study covers 50-year lifecycle
- Compares baseline "without project" condition to identified alternatives
- Results in Major Rehabilitation Evaluation Report decision document recommending long term **PLAN** for both bridges.

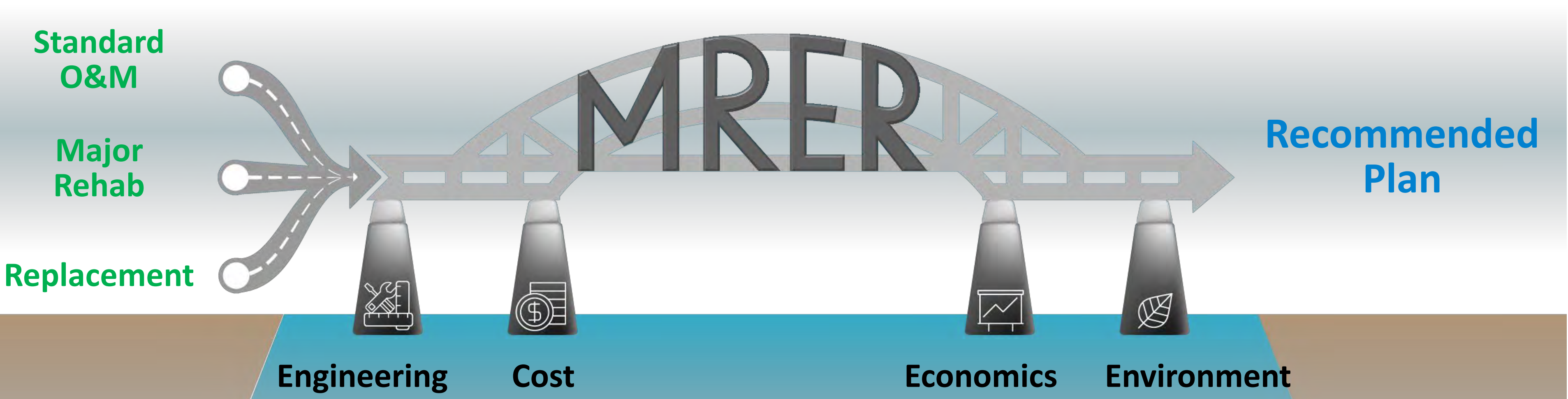
IF anticipated maintenance =

> $20M **AND** **> 2 Years**

then

Major Rehab Evaluation is required

The Major Rehabilitation Evaluation Report



- Risk & Reliability Analysis
- Define Problem / Opportunities
- Probability of Unsatisfactory Performance

- Alternatives to correct problem
- Cost and Economic Benefit of Alternatives
- Environmental Compliance

The MRER will NOT . . .

Result in final bridge design

- Additional public input incorporated during design phase, after completion of the MRER.

Initiate construction

Guarantee funding

- Selected alternative will require appropriations and may require Congressional authorization

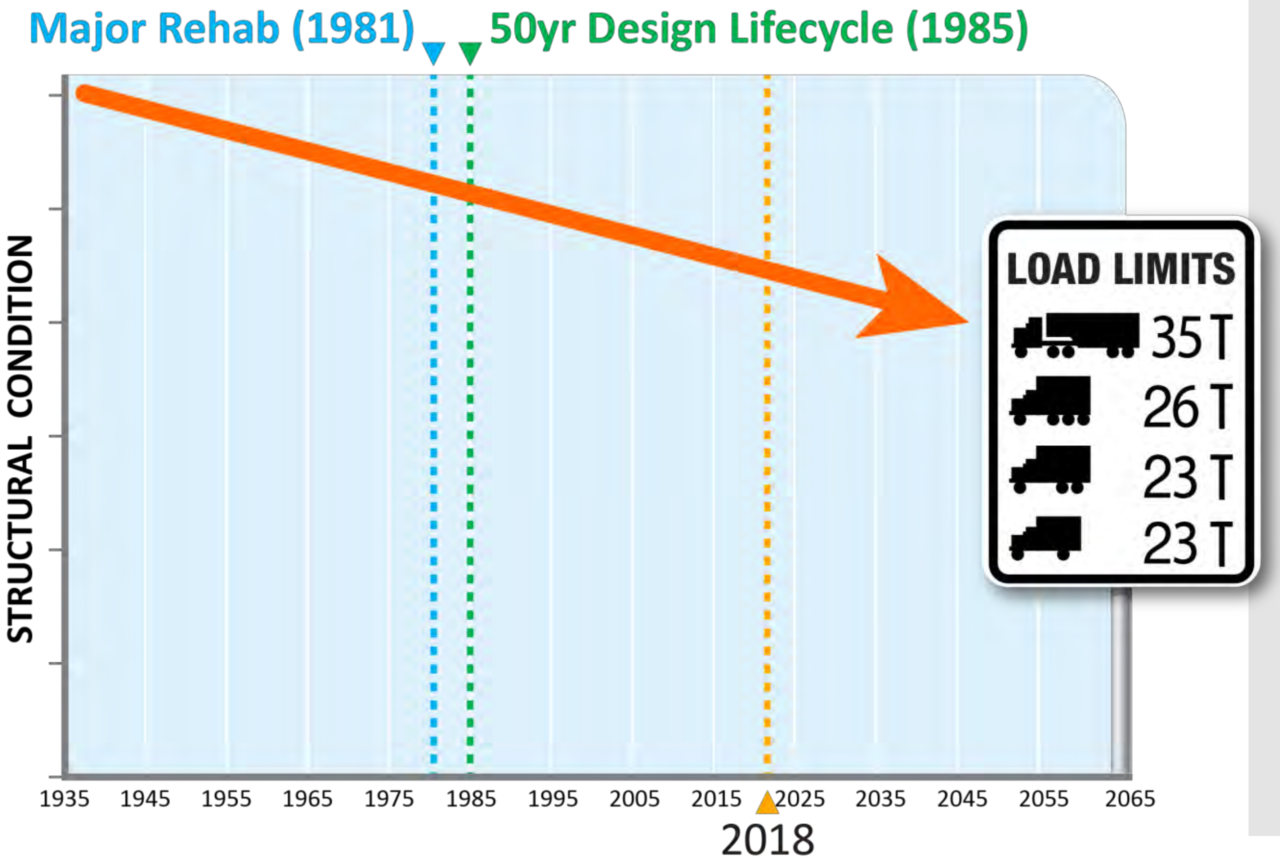
Initial MRER Alternatives

- Without project (baseline)
- Major rehabilitation
- Replacement with current authorization
- Replacement including auxiliary lanes

Other alternatives will be considered as they are identified through the public involvement and National Environmental Policy Act (NEPA) process.

ALTERNATIVE

Without Project - Baseline



- Involves continued inspection and maintenance of the bridges
- Not a sustainable long-term approach
- Will eventually lead to load limitations; posting of bridges
- Does not meet Satisfactory Performance

ALTERNATIVE

Major Rehabilitation

Major structural components are repaired or replaced

Extends life of bridges without load limitations in near term

Required twice during the next 50 years (per bridge)

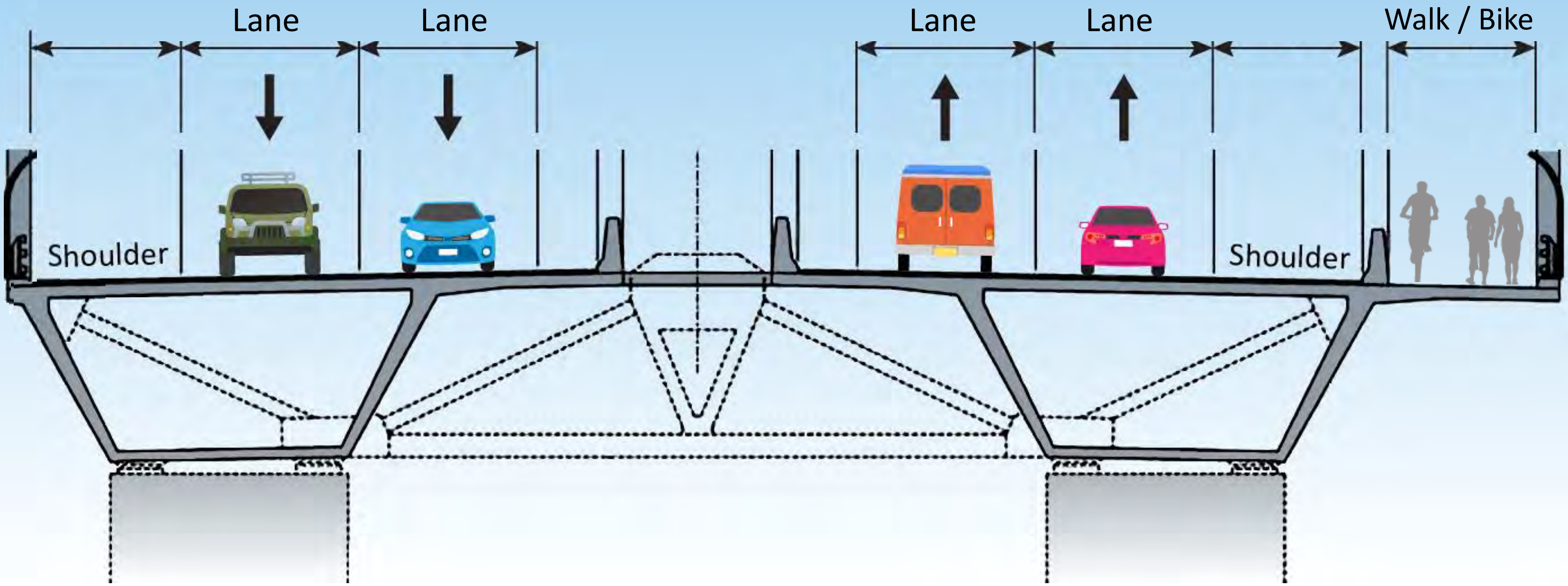
Reality of Major Rehabilitation…

BEFORE

AFTER

ALTERNATIVE

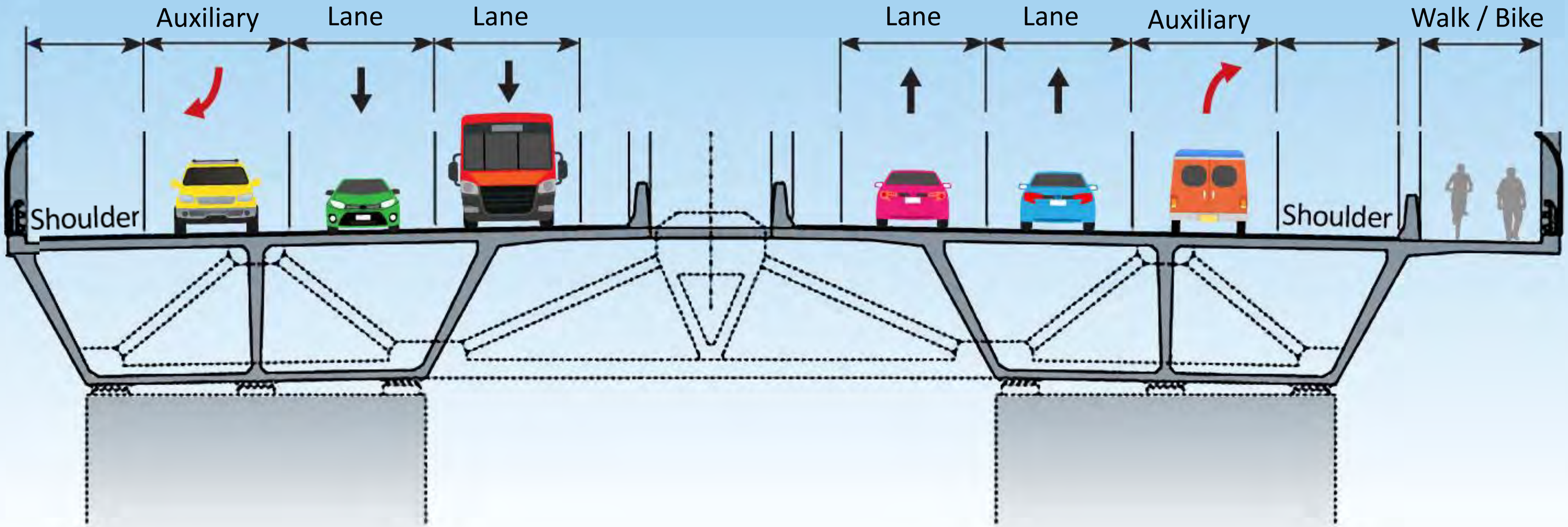
Replacement as Authorized



- 4-lane design
  (2 travel lanes each way)
- New bridges would be built next to existing bridges using Federal Highway standards
- Current bridges would remain operational during construction
- Existing bridges would be removed post construction

ALTERNATIVE

Replacement Including Auxiliary Lanes



- 4-lane design + 2 auxiliary lanes (acceleration / deceleration)
- New bridges would be built next to existing bridges using Federal Highway standards
- Current bridges would remain operational during construction
- Existing bridges would be removed post construction

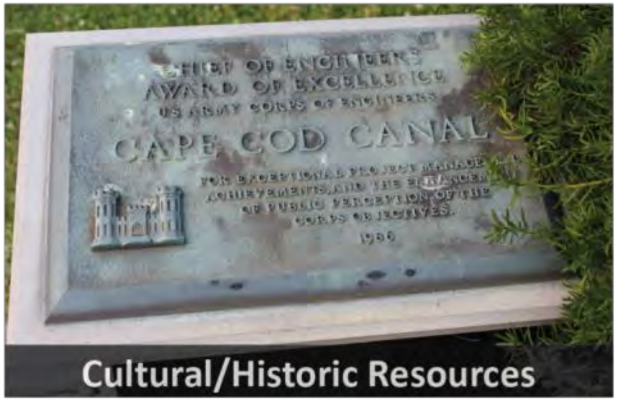
Environmental Assessment through National Environmental Policy Act (NEPA)

Wetlands

Water Quality

Wildlife/Fisheries

NEPA related analyses will be undertaken



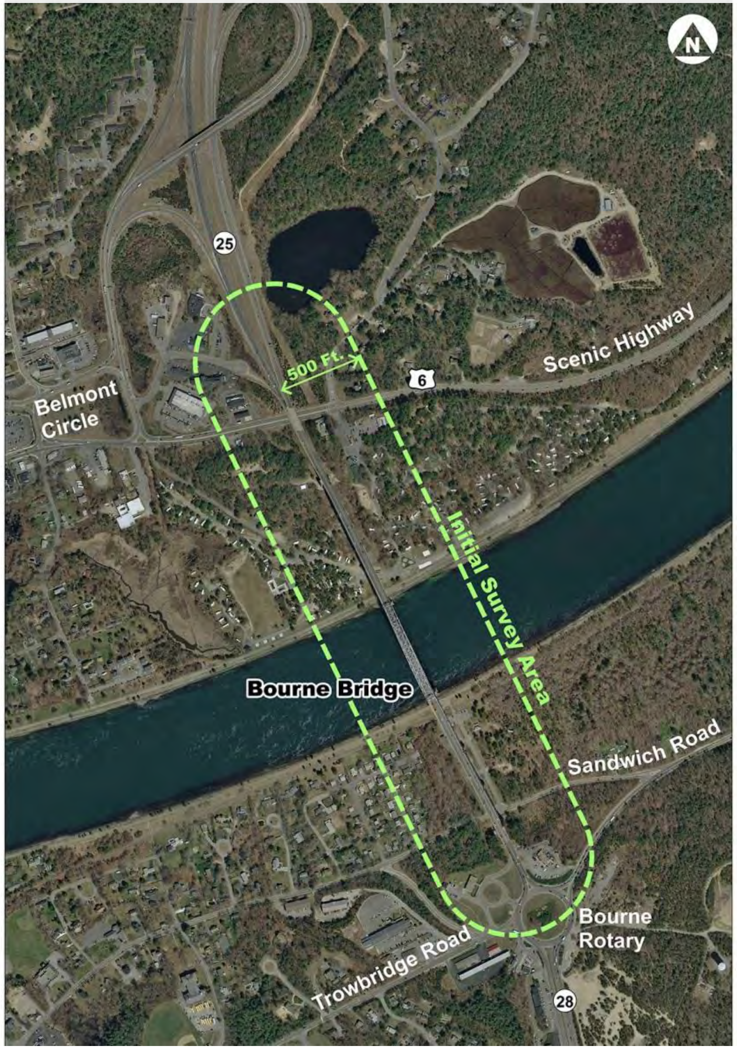
Cultural/Historic Resources

Air/Noise

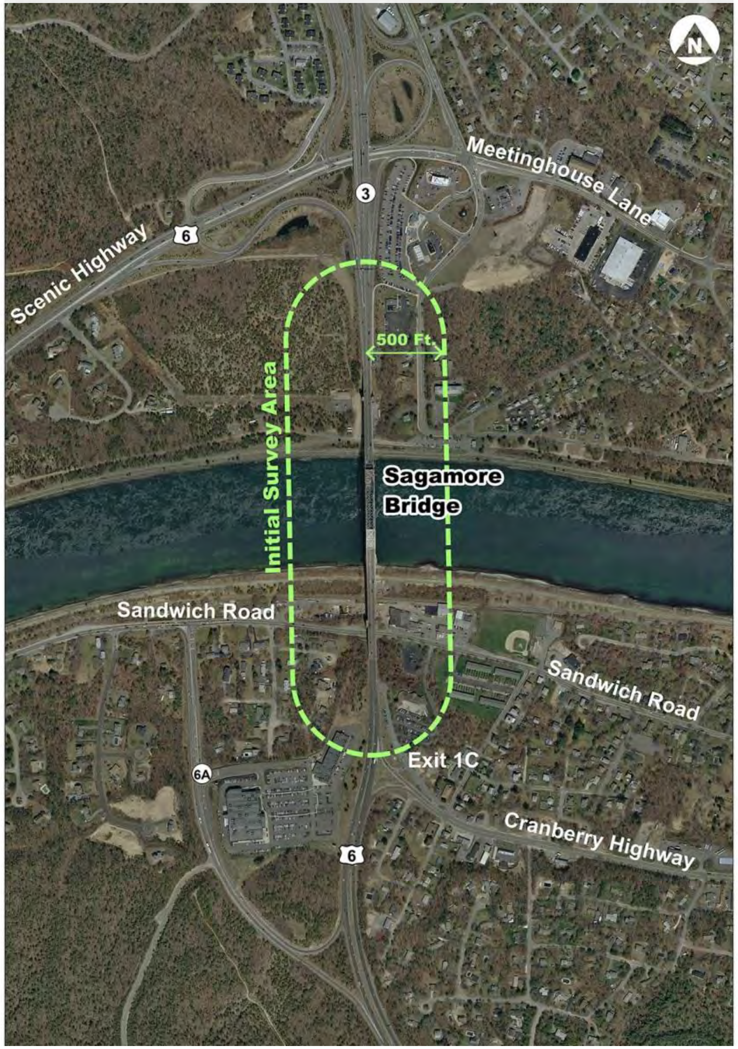
Land Use/Recreation

Map of Existing Bridges and Initial Survey Areas

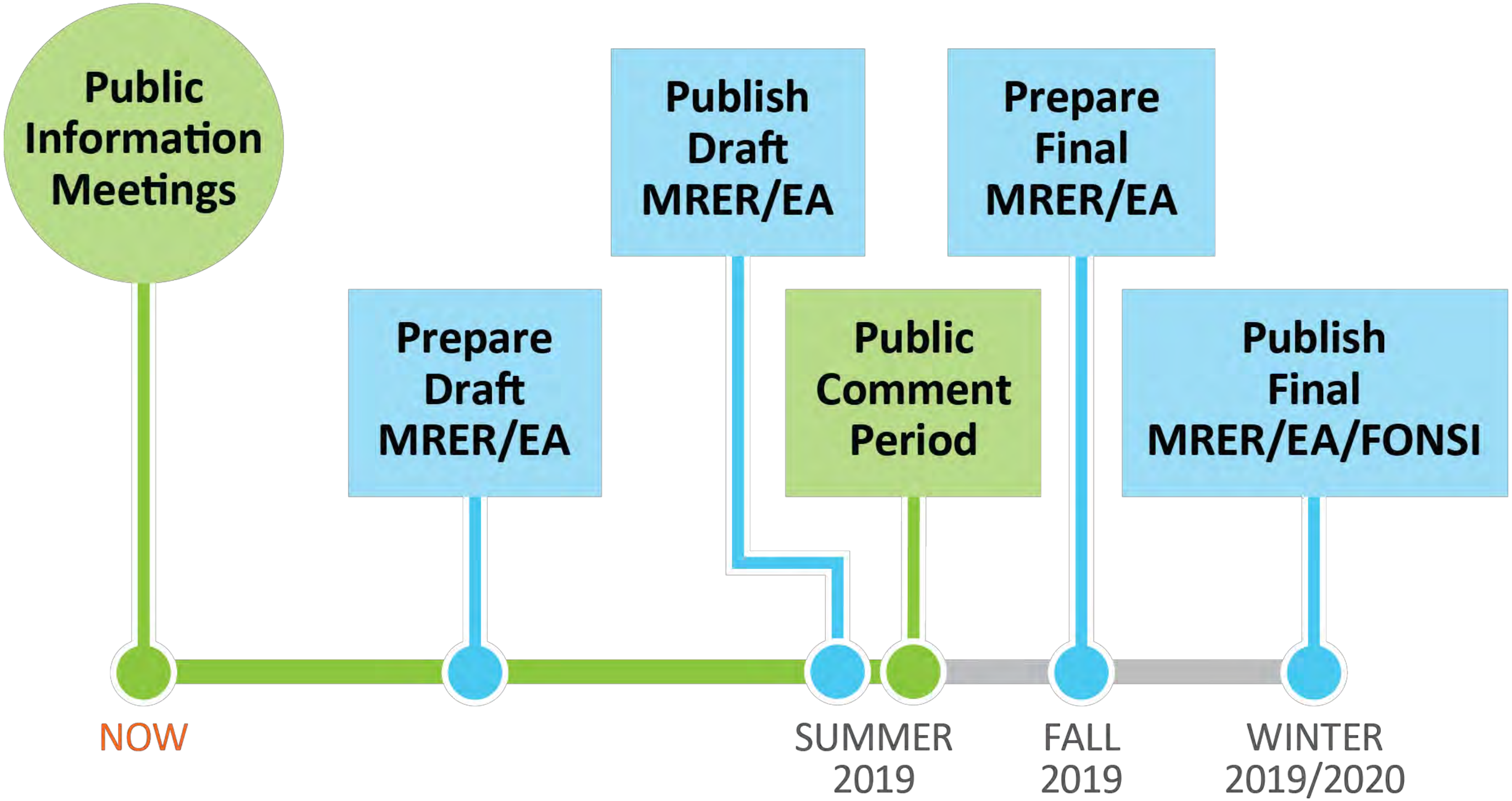
BOURNE BRIDGE



SAGAMORE BRIDGE



MRER Study & NEPA Timeline



Public Information Meetings

Prepare Draft MRER/EA

Publish Draft MRER/EA

Public Comment Period

Prepare Final MRER/EA

Publish Final MRER/EA/FONSI

NOW

SUMMER 2019

FALL 2019

WINTER 2019/2020

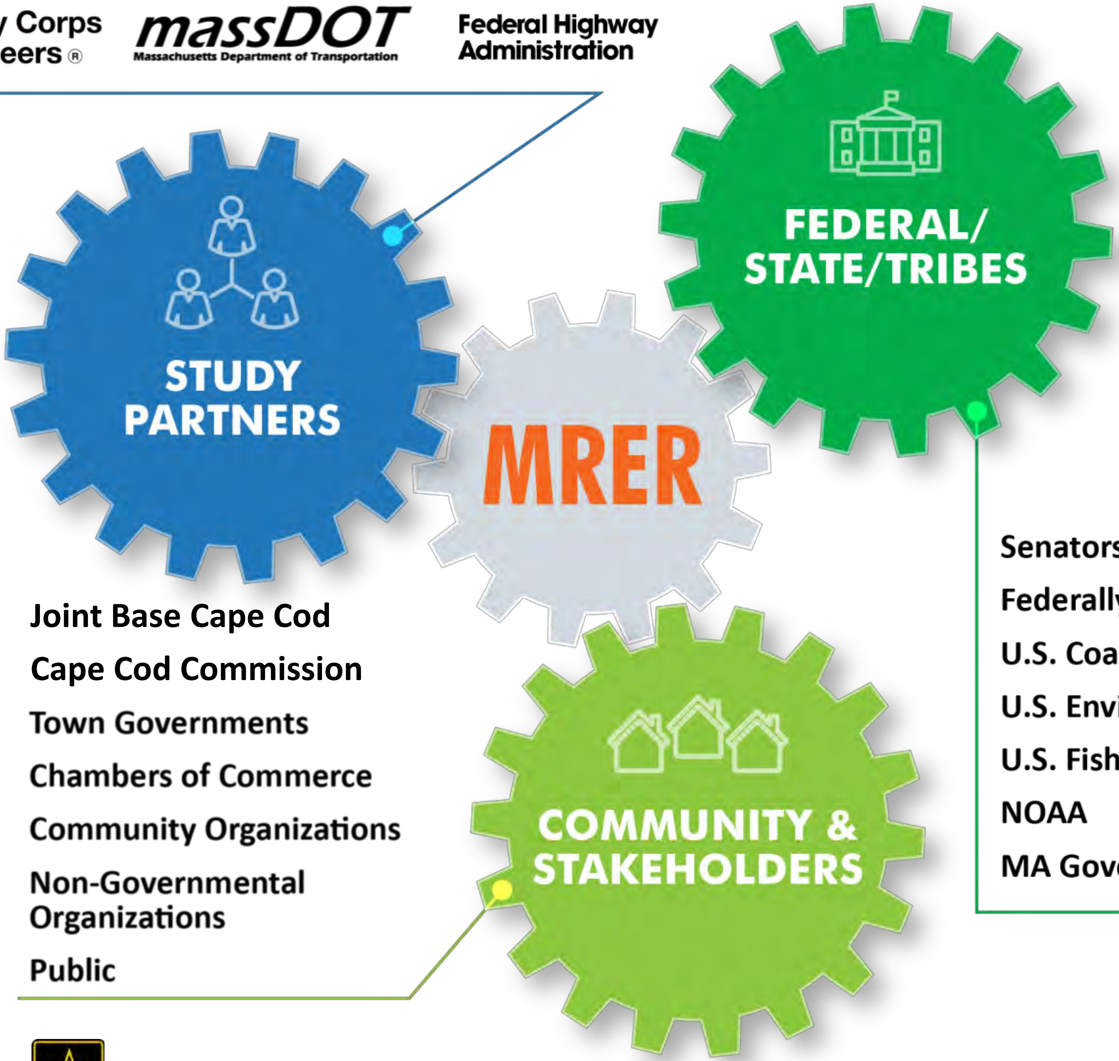
(● = Opportunity for public input)

US Army Corps of Engineers

massDOT
Massachusetts Department of Transportation

U.S. Department of Transportation
Federal Highway Administration

Partnerships
for a Successful Outcome



Senators and Representatives

Federally Recognized Tribes

U.S. Coast Guard

U.S. Environmental Protection Agency

U.S. Fish and Wildlife Service

NOAA

MA Government Agencies

Joint Base Cape Cod

Cape Cod Commission

Town Governments

Chambers of Commerce

Community Organizations

Non-Governmental Organizations

Public

Opportunities to comment

Your input is important!

- Your comments at public meetings will be recorded
- Written comments will also be accepted
- Initial comment period begins December 4, 2018
- Second public comment period begins after the Draft MRER/EA is published

Thank you for your participation!

How to submit your comments

Comments can be voiced at public meetings and will be recorded.

Submit comments online:
www.CapeCodCanalBridgesStudy.com

Written comments will also be accepted…

Mail comments:
U.S. Army Corps of Engineers
Attn: Cape Cod Canal Bridges Study NEPA Coordinator
696 Virginia Road
Concord, MA 01742

This Page Intentionally Left Blank

PRE-DRAFT EA PUBLIC COMMENTS

This Page Intentionally Left Blank

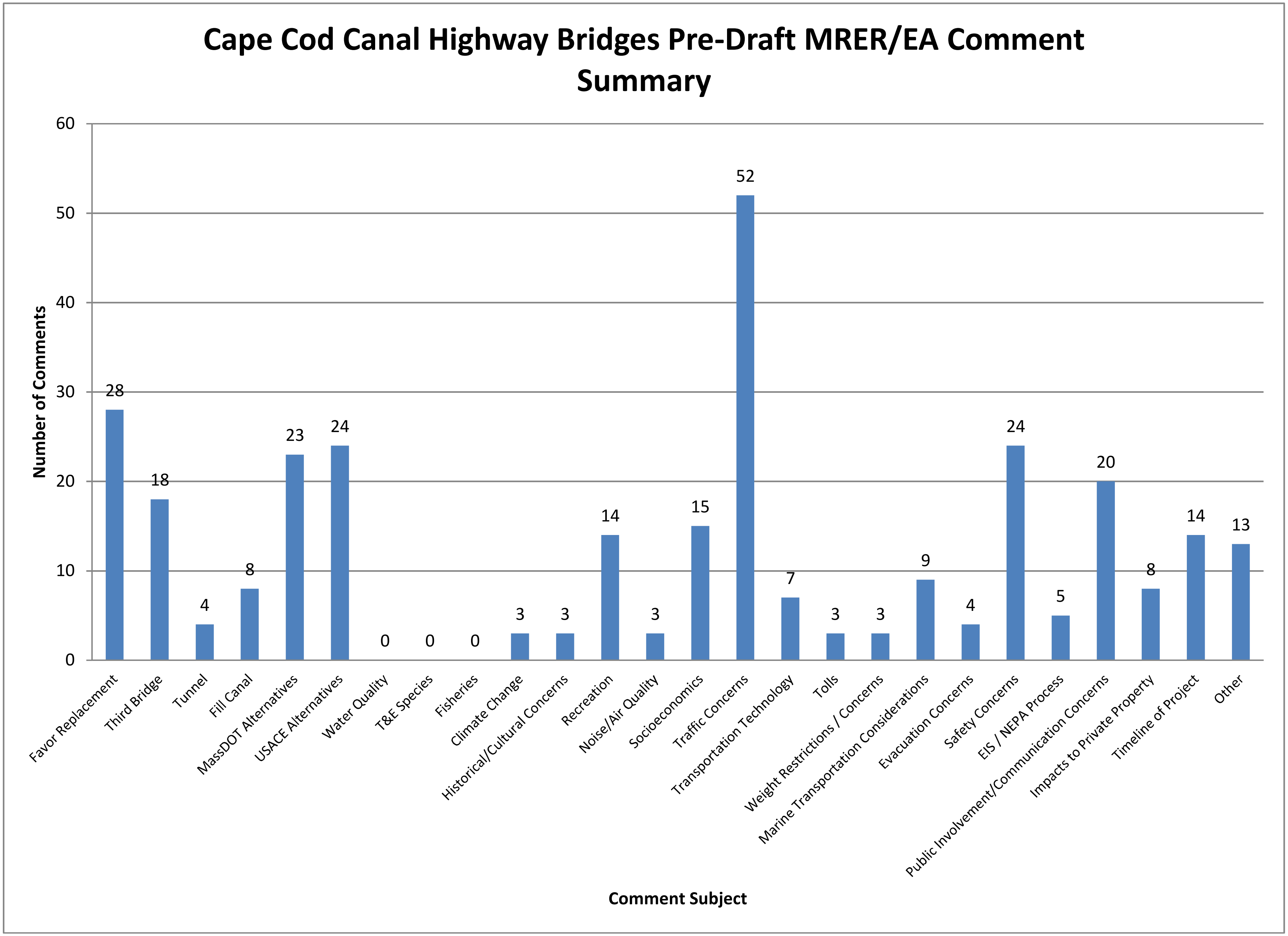

Cape Cod Canal Highway Bridges Pre-Draft MRER/EA Comment Summary

TABLE OF PUBLIC COMMENTS PRIOR TO DRAFT MRER/EA PUBLICATION

Comment #	Affiliation	Add to Mailing List (Yes/No)	Comment Date	Comment Type	Comment Subject																										Specific Comments/Questions
					ALTERNATIVES						ENVIRONMENTAL CONCERNS								TRANSPORTATION					OTHER							
					Favor Replacement	Third Bridge	Tunnel	Fill Canal	MassDOT Alternatives	USACE Alternatives	Water Quality	T&E Species	Fisheries	Climate Change	Historical/Cultural Concerns	Recreation	Noise/Air Quality	Socioeconomics	Traffic Concerns	Transportation Technology	Tolls	Weight Restrictions / Concerns	Marine Transportation Considerations	Evacuation Concerns	Safety Concerns	EIS / NEPA Process	Public Involvement/Communication Concerns	Impacts to Private Property	Timeline of Project	Other	
1	Private Citizen	Yes	12/4/2018	Website	X				X																X						I am in favor of replacing Bourne and Sagamore bridges and removing the Bourne rotary. The bridges have reached their end of life point and are too narrow for safe travel in 2018. Please incorporate a barrier down the middle of the new bridges to prevent head on collisions
2	Verizon	Yes	12/4/2018	Written																							X				Verizon would like to be kept in the consideration and design process. We have conduit and cable on both bridges that need to be kept intact to maintain communication services across the bridges.
3	Cape Cod Tech Council Blue Economy RDTN	Yes	12/4/2018	Written																X							X				1. Given tech advances in transportation and other sectors impacting and influencing transportation, are we considering canal crossing solutions that are non-traditional and innovative? 2. What are we doing to involve young people in developing solutions? Even 12-21 year-olds? 3. Are we securing insights from major logistics companies?
4	Private Citizen	Yes	12/4/2018	Written	X	X													X												Complete replacement of both bridges. Adding a third lane and Bourne Bridge Flyover. Third lane added to MacArthur Blvd. Three lanes fit naturally a the Sagamore. Concerns on a "rehab" would be closing one or both bridges. New Bridges would allow easy motorist travel. Rehab and maintenance will be almost as costly as replacing. I have included some rough estimates on cost and where the funds can be acquired based on some research I have done. New bridges, in my opinion, is the ONLY option we have. (See written comment for detailed cost estimates)
5	Private Citizen	Yes	12/4/2018	Written		X																			X					X	1. Safety - I would request that speed limit for 16 wheelers etc. to 20-25 mph to reduce the stress until the new structures are built. 2. Enclosed find my first ideas - but it is too early for me to "support it" as I do not know the costs. Actually, I'm thinking abutting the actual ones - isn't too bad - but the third bridge would take most tourist traffic - Good luck - I was active R.E. for 35 years! (See written comment for details)
6	Private Citizen	Yes	12/4/2018	Written		X													X												In favor of a third bridge. A feasible solution is to build a new bridge over the middle of the canal. In favor of tolls on the third bridge. (See written comment for more details)
7	Chairman/Board of Selectmen (Bourne, MA)	No	12/4/2018	Public Meeting																							X				• Commented that the Bourne residents are impacted the most by the decision and asked that the USACE regularly update Town of Bourne officials on the progress of the study. • Invited the USACE to meet with the Town of Bourne Board of Selectmen to update them on the MRER Study. • Stated that Bourne is a small, but important community relative the Canal Bridges and the MRER Study.

TABLE OF PUBLIC COMMENTS PRIOR TO DRAFT MRER/EA PUBLICATION

Comment #	Affiliation	Add to Mailing List (Yes/No)	Comment Date	Comment Type	Comment Subject																										Specific Comments/Questions
					ALTERNATIVES						ENVIRONMENTAL CONCERNS								TRANSPORTATION					OTHER							
					Favor Replacement	Third Bridge	Tunnel	Fill Canal	MassDOT Alternatives	USACE Alternatives	Water Quality	T&E Species	Fisheries	Climate Change	Historical/Cultural Concerns	Recreation	Noise/Air Quality	Socioeconomics	Traffic Concerns	Transportation Technology	Tolls	Weight Restrictions / Concerns	Marine Transportation Considerations	Evacuation Concerns	Safety Concerns	EIS / NEPA Process	Public Involvement/Communication Concerns	Impacts to Private Property	Timeline of Project	Other	
8	Member of the Cape Cod Commission	No	12/4/2018	Public Meeting					X										X								X		X		• Disappointed in lack of coordination/involvement by the USACE with the Cape Cod Commission, as well as the omission of the Cape Cod Commission on the Partnerships slide with the presentation. • Stated he would like more specific timelines for progress of the MRER Study. • Commented that there was no mention of the MassDOT study's "southside connector" within the USACE presentation of alternatives under consideration for the MRER study. • Believes the Commonwealth of Massachusetts/MassDOT should be responsible for all decisions regarding the Canal Bridges and associated traffic concerns.
9	Private Citizen	No	12/4/2018	Public Meeting	X					X								X	X				X								• Concerned with property values in the area/region if USACE/MassDOT continue to conduct studies on the traffic issues, but do not act. • Stated that if MassDOT continues to improve roads surrounding the bridges, but there are no improvements to the Canal Bridges it may lead to greater traffic problems. • Not in favor of just four (4) lanes of travel on the Canal Bridges or proposed replacements. • Need more access approaching both Bridges. • Stop looking at Joint Base Cape Cod (JBCC) as a significant entity that should be avoided relative to new transportation infrastructure. • Believes there is no significant commercial shipping and/or marine vessel (i.e., LNG tankers, cruise ships, commercial shipping, etc.) use of the Canal; therefore the large bridges to provide clearance for marine vessel traffic are no longer needed; Would like to see less expensive, causeway style bridges be considered and a freeway through JBCC.
10	Private Citizen	No	12/4/2018	Public Meeting		X				X											X										• Proposed a third bridge in the middle of the canal for highway access to both the north and south and to JBCC. • In favor of tolls on the bridges in order to pay for the third bridge. • Believes a third bridge would reduce wear-and-tear and maintenance requirements on the current bridges.
11	Private Citizen	No	12/4/2018	Public Meeting					X	X									X										X		• Disappointed in lack of details in the presentation for proposed alternatives. • Stated the problem is the traffic surrounding the bridges. • Concerned that the 50-year timeframe horizon for the MRER Study is too short.
12	Private Citizen	No	12/4/2018	Public Meeting		X																									• In favor of a third bridge; believes any proposed bridge should have six lanes plus a bike/pedestrian lane.
13	Private Citizen	No	12/4/2018	Public Meeting		X			X									X	X									X			• Disappointed that a third bridge alternative is not included in the primary alternatives under consideration in the MRER Study. • Stated that the Bourne residents are impacted the most by any decision coming out of the MRER Study. • MassDOT gateways and side roads need to be considered in MRER Study. • Would like to know what the process is for use of Eminent Domain related to any proposed replacement bridges.

TABLE OF PUBLIC COMMENTS PRIOR TO DRAFT MRER/EA PUBLICATION

					Comment Subject																										
					ALTERNATIVES						ENVIRONMENTAL CONCERNS								TRANSPORTATION					OTHER							
Comment #	**Affiliation**	**Add to Mailing List (Yes/No)**	**Comment Date**	**Comment Type**	**Favor Replacement**	**Third Bridge**	**Tunnel**	**Fill Canal**	**MassDOT Alternatives**	**USACE Alternatives**	**Water Quality**	**T&E Species**	**Fisheries**	**Climate Change**	**Historical/Cultural Concerns**	**Recreation**	**Noise/Air Quality**	**Socioeconomics**	**Traffic Concerns**	**Transportation Technology**	**Tolls**	**Weight Restrictions / Concerns**	**Marine Transportation Considerations**	**Evacuation Concerns**	**Safety Concerns**	**EIS / NEPA Process**	**Public Involvement/Communication Concerns**	**Impacts to Private Property**	**Timeline of Project**	**Other**	**Specific Comments/Questions**
14	Private Citizen	No	12/4/2018	Public Meeting															X												• Member of the Pile Driver's Union Local 56 • Frequent traveler of the bridges for work in Boston and needs good access to the north. • Stated working tradesmen will be significantly affected by any proposed alternatives under consideration within the MRER Study. • Would like to know what the USACE is doing to lessen the impact for the local tradesmen.
15	Private Citizen	No	12/4/2018	Public Meeting			X																								• Would like clarification on whether USACE is proposing, in the long term, to replace both Canal Bridges with a single new bridge? Or maintenance of both existing Canal Bridges with the addition of a third bridge? • Would like a tunnel feasibility study completed. Prefers a tunnel alternative rather than a third bridge. • Can a new rail bridge/tunnel be accommodated in new tunnel design?
16	Private Citizen	No	12/4/2018	Public Meeting						X										X							X				• Encouraged the MRER Study take into consideration the latest technology in transportation (i.e., driverless vehicles, etc.) when evaluating alternatives for the future. • Stated that the USACE needs to look to the future of technology in transportation that will occur within the next 50 years. • Would like the USACE to involve young people in the process for new ideas on traffic solutions. Believes USACE would be surprised with comments from 15-18 year olds.
17	Private Citizen	No	12/4/2018	Public Meeting																										X	• Recognized the USACE for their work and continued safety of the Bridges.
18	Private Citizen	No	12/4/2018	Public Meeting	X				X							X			X	X					X		X				• Lives on the Cape and travels to mainland for work. • Recognized the USACE for their quick response to fix road maintenance issues (i.e., potholes, etc.). • Welcomed any effort to improve safety on the Bridges. • Believes vehicle operators are the biggest safety issue, and believes there are measures USACE could enact currently to improve safety; would like to see reduced speed limits approaching the Bridges. • Would like the USACE to work with MassDOT for safe planning for bicycle connections to the Bridges. • Would like USACE to consider adaptability for future transportation technologies (vehicle-to-vehicle communication for driverless or semi-autonomous vehicles). • In concept, supports two new bridges and looks forward to more details.

TABLE OF PUBLIC COMMENTS PRIOR TO DRAFT MRER/EA PUBLICATION

Comment #	Affiliation	Add to Mailing List (Yes/No)	Comment Date	Comment Type	Comment Subject																										Specific Comments/Questions
					ALTERNATIVES						ENVIRONMENTAL CONCERNS								TRANSPORTATION					OTHER							
					Favor Replacement	Third Bridge	Tunnel	Fill Canal	MassDOT Alternatives	USACE Alternatives	Water Quality	T&E Species	Fisheries	Climate Change	Historical/Cultural Concerns	Recreation	Noise/Air Quality	Socioeconomics	Traffic Concerns	Transportation Technology	Tolls	Weight Restrictions / Concerns	Marine Transportation Considerations	Evacuation Concerns	Safety Concerns	EIS / NEPA Process	Public Involvement/Communication Concerns	Impacts to Private Property	Timeline of Project	Other	
19	Private Citizen	No	12/4/2018	Public Meeting																						X	X				• Retired environmental engineer having worked with several different federal agencies in Washington DC. • Stated that the National Environmental Policy Act (NEPA) process doesn't work as it was intended. • Noted that the USACE wrote an Environmental Impact Statement (EIS) for the Nantucket wind farm, which never became a viable project; but thought the MRER Study presentation glossed over consideration that replacement of the Bridges would have a significant impact on human environment not just biological, which would require an EIS not an Environmental Assessment (EA). • Disappointed that the format of the public information meeting was not a question-and-answer (Q & A) style format.
20	Vice Chairperson for Town of Bourne Board of Selectmen and liaison to Cape Cod Commission Cape Cod Metropolitan Planning Organization	No	12/4/2018	Public Meeting														X	X						X		X	X	X		• Interested in the transportation needs of the Cape Cod Canal area, but is concerned that there is not an integrated conversation ongoing between MassDOT the USACE. • Believes there is a disconnect in the MRER Study timeline, and wonders when an integrated conversation with local community is going to happen regarding the MRER Study? • Would like to know the location of the replacement bridges. • Stated that the placement of the new bridges affects businesses and eminent domain considerations along the Canal. • Noted that Bourne provides all emergency response on the Bourne Bridge and rotary. • Questions how the Town of Bourne is to respond to hazardous materials transportation across the Bourne Bridge?
21	Town of Bourne Town Administrator	No	12/4/2018	Public Meeting															X							X	X		X		• Believes that completing the NEPA process/issuance of a Finding of No Significant Impact (FONSI) prior to acquisition of funding for the proposed alternative seems backwards. • Stated that 3.5 year timeframe to complete a major rehabilitation per bridge, is seven (7) years times two over a 50 year time span, which a lot of time and doesn't take into account annual maintenance, which also requires lane closures. • Noted that the bridges are busy going both on and off the Cape during the morning commute, and the disruption associated with lane closures for a significant duration to complete a major rehabilitation would be an unacceptable impact. • Believes Bourne has the greatest impact as a result of the traffic not only on weekdays, but also the weekends; Bourne also bears the greatest responsibility to provide emergency response to Bourne bridge and rotary. • Would like to see a joint conversation between USACE and the local Bourne community regarding the MRER Study and proposed alternatives.
22	Private Citizen	No	12/4/2018	Public Meeting										X																	• Stated that climate change and floodplains/flood zones, and changes to the area over the next 50 years as a result of climate change and government redrawing of flood zones should be taken into account within the reports developed for the project.

TABLE OF PUBLIC COMMENTS PRIOR TO DRAFT MRER/EA PUBLICATION

Comment #	Affiliation	Add to Mailing List (Yes/No)	Comment Date	Comment Type	Comment Subject																											Specific Comments/Questions
					ALTERNATIVES						ENVIRONMENTAL CONCERNS								TRANSPORTATION					OTHER								
					Favor Replacement	Third Bridge	Tunnel	Fill Canal	MassDOT Alternatives	USACE Alternatives	Water Quality	T&E Species	Fisheries	Climate Change	Historical/Cultural Concerns	Recreation	Noise/Air Quality	Socioeconomics	Traffic Concerns	Transportation Technology	Tolls	Weight Restrictions / Concerns	Marine Transportation Considerations	Evacuation Concerns	Safety Concerns	EIS / NEPA Process	Public Involvement/Communication Concerns	Impacts to Private Property	Timeline of Project	Other	
23	Private Citizen	No	12/4/2018	Public Meeting	X				X										X												• Lives off Cape and owns a business in Falmouth. • Stated detours during major rehabilitation and routine maintenance causes increase in commuting times, both during the summer and off-season. • In favor of replacement of both Bridges with additional auxiliary lanes. • Wonders why no flyover project for Bourne Bridge rotary been approved as of yet? • Would like to see additional travel lanes on Route 28 south of the Bourne rotary. • This would allow for increased use of businesses on MacArthur Blvd.
24	Town of Bourne Assistant Town Administrator	No	12/4/2018	Public Meeting														X				X		X							• Would like to see an economic analysis of impact if weight restrictions are implemented on the Bridges. • Stated that evacuation routes and requirements should be considered in design of the MRER Study alternatives.
25	Private Citizen	No	12/5/2018	Public Meeting														X	X							X	X				• Former federal government environmental engineer. • Stated that an EA is thought of by bureaucrats as a way to avoid the need for an EIS. • Believes the EA should be used as a foundation for both biological and human (i.e., socio-economic) environment impacts. • Stated that it is not clear how much traffic (or how much more traffic) the replacement bridges would carry onto Cape Cod. • What are the economic impacts to the Cape and surrounding towns, and businesses as a result of this extra traffic? • Disappointed that the format of the meeting was not a Q&A style format in order for the public to get clarification on their questions.
26	District Representative for Senator deMacedo (Bourne, Plymouth, and Falmouth District)	Yes	12/5/2018	Public Meeting																							X				• Stated that going forward she hopes that Senator deMacedo is included in the MRER Study process. • Concerned that public groups were not notified of the public meetings. • She would like to be added to the mailing list.
27	Private Citizen	Yes	12/5/2018	Website					X	X																	X		X		A disappointing meeting. 1. I expected to at least see alternatives for replacement 2. No specific timelines for specific study tasks and targeted completion dates for study tasks. 3. No involvement of the Cape Cod Commission, the Cape's Regional Transportation Planning Organization. 4. Little information presented on how MA DOT and the Army Corp are working together to reach the best transportation solution (Bridge & Roads) for the Cape region.

TABLE OF PUBLIC COMMENTS PRIOR TO DRAFT MRER/EA PUBLICATION

Comment #	Affiliation	Add to Mailing List (Yes/No)	Comment Date	Comment Type	Comment Subject																										Specific Comments/Questions
					ALTERNATIVES						ENVIRONMENTAL CONCERNS								TRANSPORTATION					OTHER							
					Favor Replacement	Third Bridge	Tunnel	Fill Canal	MassDOT Alternatives	USACE Alternatives	Water Quality	T&E Species	Fisheries	Climate Change	Historical/Cultural Concerns	Recreation	Noise/Air Quality	Socioeconomics	Traffic Concerns	Transportation Technology	Tolls	Weight Restrictions / Concerns	Marine Transportation Considerations	Evacuation Concerns	Safety Concerns	EIS / NEPA Process	Public Involvement/Communication Concerns	Impacts to Private Property	Timeline of Project	Other	
28	Private Citizen	Yes	12/5/2018	Website		X																									I live is south Plymouth by the Bourne bridge and use the Sagamore to get to work in South Yarmouth every day. Seems to me that a great solution would be to put a third bridge in the middle of the canal that connects Rt 25 by Bourne Rd/Plymouth Ln with Rt 6 just after exit 2. There is a power line trail that runs through Cape Cod Aggregates that looks like a natural route. This would offload traffic coming off Rt 6 looking to get to 495 and vice versa. If people were really thinking, this would be a great way to create and exit for the Ponds traffic as well. Take a look at a satellite view of the area and you will see how well this works.
29	Private Citizen	Yes	12/5/2018	Website				X																							Fill in the canal in the middle. Make it a green way
	Old Colony Planning Council	Yes	12/5/2018	Website																										X	Please add me to your contact list. Thank you.
30	Private Citizen	No	12/6/2018	Public Meeting										X		X							X		X						• Will the design of the replacement bridges allow for larger ships to use the Canal? • How are more extreme weather events being incorporated into the replacement bridges design? • Stated that the current bridges are dangerous for pedestrian use and the USACE should take into account other forms of transit in design of replacement bridges.
31	Private Citizen	No	12/6/2018	Public Meeting	X																				X						• Would like to see both Bridges replaced one at a time with lane expansions. • Believes the Bridges are currently unsafe due to motor vehicle accidents.
32	Private Citizen	Yes	12/6/2018	Website					X							X	X		X		X							X			Several questions on proposed bridge construction: 1. Will there be noise and light pollution mitigation steps taken during construction? Backup alarms on forklifts and construction equipment are particularly annoying. 2. Will new bridge design include features to slow down traffic to posted speed limits and discourage lane changes? 3. Will pedestrian and bicycle lane be designed in such a way that it will afford year round, all weather access in order to transit over the bridge? 4. Will bridge continue to be toll free? Does MASSDOT have the ability to institute tolls on the access roads even if the Corps of Engineers is prohibited from making the bridge a toll bridge? 5. Will bridge design and access road design reduce incline on road over the canal? Seems like most motorists "floor it" when starting to ascend the bridge from either side. For those of us that live near the bridge
33	Private Citizen	Yes	12/8/2018	Website	X																									X	Hello, I'm writing this letter as a 35yr resident to the town of Bourne and a Local 7 iron worker out of Boston. First off, I know it's not Boston's justification, but we have one of the strongest unions in the country. Our work speaks for itself and for those two reasons, we should be sought after for the work. Next thing, we need new bridges. If we're going to put up new bridges, we need more lanes going in each direction, but we only need that a few months out of every year. Just some thoughts, thank you for allowing the citizens a voice.

TABLE OF PUBLIC COMMENTS PRIOR TO DRAFT MRER/EA PUBLICATION

					Comment Subject																									
					ALTERNATIVES						ENVIRONMENTAL CONCERNS								TRANSPORTATION					OTHER						
Comment #	**Affiliation**	**Add to Mailing List (Yes/No)**	**Comment Date**	**Comment Type**	**Favor Replacement**	**Third Bridge**	**Tunnel**	**Fill Canal**	**MassDOT Alternatives**	**USACE Alternatives**	**Water Quality**	**T&E Species**	**Fisheries**	**Climate Change**	**Historical/Cultural Concerns**	**Recreation**	**Noise/Air Quality**	**Socioeconomics**	**Traffic Concerns**	**Transportation Technology**	**Tolls**	**Weight Restrictions / Concerns**	**Marine Transportation Considerations**	**Evacuation Concerns**	**Safety Concerns**	**EIS / NEPA Process**	**Public Involvement/Communication Concerns**	**Impacts to Private Property**	**Timeline of Project**	**Other**	**Specific Comments/Questions**
34	Private Citizen	Yes	12/9/2018	Website												X									X						Please ensure that any replacement bridges include a first class bicycle/pedestrian walkway, well protected from adjacent lanes of motor traffic. Any rehabilitation of the current bridges should include all possible upgrades to the bicycle/pedestrian walkways to improve safety, particularly the addition of a strong barrier between the walkways and adjacent traffic lanes. Thank you.
35	Dukes County Commissioner	No	12/11/2018	Public Meeting																							X				• Complimented the thoroughness and accuracy of the USACE presentation. • Wonders when the public will know the results of the MRER Study?
36	Martha's Vineyard Commission, Cape Light Compact	No	12/11/2018	Public Meeting	X														X						X					X	• Stated he is not a daily commuter but happy to know that the Bridges are kept to safety standards. • In favor of replacement of the Bridges, as it seems like a waste of money to keep maintaining the Bridges as they are. • Questions whether the public wants more capacity on the Bridges? Thinks people will be spilt on this question.
37	Private Citizen	No	12/11/2018	Public Meeting											X	X							X	X				X			• Concerned about the bike/pedestrian lanes and believes they should be kept separate from the vehicle lanes. • Stated that there is currently no good access to the bike/pedestrian lane. • Hopes all historical items associated with removal of the existing Bridges will be cataloged and placed in a public museum. • Would like to see the Bourne Bridge and Sagamore Bridge plaques put on display for public viewing in a convenient location. • Questions if the replacement bridges would incorporate increased clearance for larger vessels to use the Canal? • Worried about use of eminent domain for replacement of the bridges. • Is there an evacuation plan being proposed as part of the MRER Study evaluation of alternatives? • Would the USACE consider using all four (4) lanes as exit lanes for an evacuation?
38	Martha's Vineyard Chamber of Commerce	No	12/11/2018	Public Meeting	X																										• In favor of replacement of the bridges with modern alternative incorporating wider lanes, additional auxiliary lanes, and the bike/pedestrian lane.
39	Executive Director, Cape Cod Commission	No	12/12/2018	Public Meeting															X						X		X				• Speaking as a representative for Steven Tupper (Cape Cod Commission Transportation Program Manager) who could not attend. • Stated that the residents of Cape Cod depend on reliable transportation routes. • Noted that the decision to replace or rehabilitate the Bridges will affect the Cape Cod communities for the long term. • Encouraged continued close collaboration with MassDOT on decisions moving forward.
40	Truro Fire Department	No	12/12/2018	Public Meeting															X						X						• Believes access to emergency services is a major issue that should be considered in the MRER Study and evaluation of alternatives.

TABLE OF PUBLIC COMMENTS PRIOR TO DRAFT MRER/EA PUBLICATION

Comment #	Affiliation	Add to Mailing List (Yes/No)	Comment Date	Comment Type	Comment Subject																										Specific Comments/Questions
					ALTERNATIVES						ENVIRONMENTAL CONCERNS								TRANSPORTATION					OTHER							
					Favor Replacement	Third Bridge	Tunnel	Fill Canal	MassDOT Alternatives	USACE Alternatives	Water Quality	T&E Species	Fisheries	Climate Change	Historical/Cultural Concerns	Recreation	Noise/Air Quality	Socioeconomics	Traffic Concerns	Transportation Technology	Tolls	Weight Restrictions / Concerns	Marine Transportation Considerations	Evacuation Concerns	Safety Concerns	EIS / NEPA Process	Public Involvement/Communication Concerns	Impacts to Private Property	Timeline of Project	Other	
41	Private Citizen	No	12/12/2018	Public Meeting															X		X								X		• Stated that the increase in traffic associated with the Bridges and area transportation infrastructure has significantly affected Cape Cod communities. • Does not want tolls on the bridges as this would put an undue burden on local residents. • Expressed concern on the timeline and would like a prompt decision on this urgent issue to speed up implementation of the solutions.
42	President of the Canal Sportsman Club	No	12/12/2018	Public Meeting																								X			• Stated that the Canal Sportsman Club property is within 500 feet of the Bourne Bridge. • How will the MRER Study and recommendations affect the club and its 101 members?
43	Private Citizen	No	12/12/2018	Public Meeting	X	X			X										X												• Believes the USACE needs to look at the transportation issues as a whole. • In favor of bridge rehabilitation or replacement along with a third bridge to disperse traffic issues. • Indicated that just adding additional lanes will not resolve the traffic issues. • Stated that MassDOT refuses to study a third bridge alternative. • The future traffic environment involves a complete package including roads and bridges.
45	Canal Sportsman Club	No	12/12/2018	Public Meeting												X												X			• Stated that the Canal Sportsman Club property line is within 150 feet of the Bourne Bridge and has been there since 1939. He would hate to see the club dislocated as a result of the Bourne bridge replacement. • How does construction on the replacement for the Bourne Bridge affect the club? • Stated he would like club access to the Canal maintained during construction.
46	Private Citizen	No	12/12/2018	Public Meeting	X														X												• In favor of replacement of the bridges in a timely fashion for smoother access to and from Cape Cod. • Would like to see consideration of use of opposite travel lanes during peak travel periods, similar to the “zipper” lane in Boston.
47	CEO, Cape Cod Chamber of Commerce	No	12/12/2018	Public Meeting	X														X				X								• Stated that the current Bridges do not meet existing traffic capacity. • In favor of replacement of both Bridges (not rehabilitation) to meet future needs. • Wants to know more about the future marine vessel capacity for the Canal based on the replacement bridge designs and wonders whether the height of the replacement bridges will inhibit vessel size through the Canal? • Stated she and the Cape Cod Chamber of Commerce are looking forward to working with USACE on the MRER Study.

TABLE OF PUBLIC COMMENTS PRIOR TO DRAFT MRER/EA PUBLICATION

					Comment Subject																										
					ALTERNATIVES						ENVIRONMENTAL CONCERNS								TRANSPORTATION					OTHER							
Comment #	Affiliation	Add to Mailing List (Yes/No)	Comment Date	Comment Type	Favor Replacement	Third Bridge	Tunnel	Fill Canal	MassDOT Alternatives	USACE Alternatives	Water Quality	T&E Species	Fisheries	Climate Change	Historical/Cultural Concerns	Recreation	Noise/Air Quality	Socioeconomics	Traffic Concerns	Transportation Technology	Tolls	Weight Restrictions / Concerns	Marine Transportation Considerations	Evacuation Concerns	Safety Concerns	EIS / NEPA Process	Public Involvement/Communication Concerns	Impacts to Private Property	Timeline of Project	Other	Specific Comments/Questions
48	Private Citizen	No	12/12/2018	Public Meeting						X								X					X		X						• Stated he is concerned with safety on the current Bridges. • Suggested a rumble strip and reflectors on double yellow lines on existing bridges to deter crossing of lanes – believes this is a cheap fix that can be implemented now to improve safety and save lives. • Would like to know what the economic impact is of the Canal by marine vessels (i.e., commercial shipping)? • Noted that the design and construction process of the Tappen Zee Bridge in New York was excellent and hoped that the USACE would look to its success as a guideline for the Canal Bridges replacement.
49	Private Citizen	No	12/12/2018	Public Meeting	X													X	X								X		X		• Disappointed in length and timeframe of the MRER Study and stated that the Bridges need to be replaced as soon as possible. • Stated that Cape Cod is a year-round destination now, and that traffic disruption is a major economic impact to the region. • Stated in order to maintain the economic environment of Cape Cod, the Bridges need to be replaced now.
50	Private Citizen	No	12/12/2018	Public Meeting	X																										• In favor of replacement of both Bridges. • Stated major rehabilitation of the Bridges would be negligent and that maintenance would continue to be costly, unsafe and inconvenient.
51	Private Citizen	No	12/12/2018	Public Meeting				X		X													X								• Believes the Canal wouldn't have been created today if it was proposed as a new project, and doesn't think the Canal is currently being used for its previously intended purpose. • Would prefer crossings of the Canal similar to those in the Back Bay of Boston crossing the Charles River.
52	Private Citizen	No	12/12/2018	Public Meeting																						X	X				• Stated that the website does not identify what a "MRER" is. • Believes that the USACE need to provide the public with a better understanding of the process that is being started and that this stage is the beginning of the decision making process. • Stated that the USACE should engage its Public Affairs department in Washington to talk to the public. • Disappointed that the format of the meeting was not a Q&A. • Would like to see "down Cape" be included in meeting locations.
53	Private Citizen	No	12/12/2018	Public Meeting						X									X												• Stated that the roads on Cape Cod are already at capacity and widening bridge lanes will not solve the traffic problems. • Maintaining the Bridges in their current configuration allows for the same capacity and meets the public's current needs. • Noted that the Sagamore Bridge flyovers did not alleviate traffic issues.

TABLE OF PUBLIC COMMENTS PRIOR TO DRAFT MRER/EA PUBLICATION

					Comment Subject																										
					ALTERNATIVES						ENVIRONMENTAL CONCERNS								TRANSPORTATION					OTHER							
Comment #	Affiliation	Add to Mailing List (Yes/No)	Comment Date	Comment Type	Favor Replacement	Third Bridge	Tunnel	Fill Canal	MassDOT Alternatives	USACE Alternatives	Water Quality	T&E Species	Fisheries	Climate Change	Historical/Cultural Concerns	Recreation	Noise/Air Quality	Socioeconomics	Traffic Concerns	Transportation Technology	Tolls	Weight Restrictions / Concerns	Marine Transportation Considerations	Evacuation Concerns	Safety Concerns	EIS / NEPA Process	Public Involvement/Communication Concerns	Impacts to Private Property	Timeline of Project	Other	Specific Comments/Questions
54	Private Citizen	No	12/12/2018	Public Meeting		X			X	X						X			X				X						X		• Concerned with traffic patterns and believes the USACE is not acting fast enough to fix traffic problems. • Is the only alternative being considered is replacement of both Bridges? Could there be one larger bridge proposed instead? • Could the railroad bridge be remodeled to carry traffic? • Will the study examine traffic patterns and exit locations, especially at Exit 1 at the base of the Sagamore Bridge? Traffic getting off Route 6 and trying to avoid traffic by taking Route 6A and merging back onto Route 6 at Exit 1C is what is causing the real traffic congestion. • Stated that traffic circle at the Bourne Bridge needs to be addressed. • State that bike/pedestrian access to the Bridges is a real issue and needs to be considered; In favor of the bike/pedestrian lanes. • USACE/MassDOT should look at using JBCC vacant land for solutions to traffic issues. • What is the marine vessel use of the Canal? What size marine vessels are using the Canal? This needs to be considered in the evaluation of potential alternatives within the MRER Study. • The USACE should consider the use/addition of commuter rail on the replacement bridges.
55	Private Citizen	No	12/12/2018	Public Meeting				X		X																					• Stated Cape Cod residents are living with the results of decisions made 100 years ago. • Believes the Canal is obsolete. Is there any consideration of filling in the Canal to remove the obstacle to traffic infrastructure?
56		No	12/12/2018	Written		X													X											X	1. Add a third bridge. 2. Concern with natural gas pipeline crossing the canal. Can they be put underground and not crossing the bridges? 3. The cape is now over populated. Please consider removing one bridge and having only one bridge. This will help to restrict the flow of visitors to the cape.
57	Private Citizen	Yes	12/12/2018	Written		X			X	X						X			X				X								1. Is the only model two bridges? 2. Can the railroad bridge be remodeled to handle cars and trains (as in Alaska)? 3. Will the studies examine the problems with roads (and entrances) leading to/from the bridges? 4. Space planned for bikes and pedestrians? 5. Can some of the Air Force base land be used to accommodate access and regress from the bridges? 6. Survey the use of the canal, especially large ships. How many? And how tall are the ships including their masts? Also, pleasure craft especially sailing vessels. 7. What about a rail lane in the middle? i.e. trolley/subway

TABLE OF PUBLIC COMMENTS PRIOR TO DRAFT MRER/EA PUBLICATION

					Comment Subject																										
					ALTERNATIVES						ENVIRONMENTAL CONCERNS								TRANSPORTATION					OTHER							
Comment #	Affiliation	Add to Mailing List (Yes/No)	Comment Date	Comment Type	Favor Replacement	Third Bridge	Tunnel	Fill Canal	MassDOT Alternatives	USACE Alternatives	Water Quality	T&E Species	Fisheries	Climate Change	Historical/Cultural Concerns	Recreation	Noise/Air Quality	Socioeconomics	Traffic Concerns	Transportation Technology	Tolls	Weight Restrictions / Concerns	Marine Transportation Considerations	Evacuation Concerns	Safety Concerns	EIS / NEPA Process	Public Involvement/Communication Concerns	Impacts to Private Property	Timeline of Project	Other	Specific Comments/Questions
58	Private Citizen	Yes	12/12/2018	Written															X						X						1. Consider putting rumble strip on center line with neon reflectors to help drivers stay in correct lane. DOT has done this on Scenic Highway. 2. Provide more obvious speed limit warning signs to get speeds down on bridges.
59	Robert Paul Properties	Yes	12/12/2018	Written														X							X				X		What would the project costs of new bridges be and timeline? My concern is that this issue has been kicked down the road for so long now and it is in a critical state - it is having an adverse effect on this region's economy.
60	Canal Sportsman Club	Yes	12/12/2018	Written												X												X			I would like to know how this project would impact our club of 101 members. We have a club house at 324 Main Street , Buzzards Bay.
61		No	12/12/2018	Written															X										X		Getting on and off cape - time it will take. How long and when it is to start and be completed.
62	Private Citizen	Yes	12/14/2018	Website					X									X	X										X		A plan needs to be moved forward as soon as possible. The current bridges can not handle today's travel. The traffic problems that are caused by bridge work are hurting the Cape Cod economy. How many people avoid the Cape when they hear of the traffic nightmares? Exit 1 leaving the Cape should be moved away from the Sagamore Bridge. Drivers use the Christmas Tree Store parking lot as a short cut. This is obviously a complicated issue. I hope the solutions are announced in the next couple of years and the construction RFP is written so that the projects are completed quickly.
63	Private Citizen	Yes	12/14/2018	Website	X														X					X	X						Please plan to replace these bridges. It is scary to drive over the narrow lanes with vehicles coming at you. The constant repairs are a nightmare for employees who live off cape and vendors bringing good and services from off Cape. Many of us live in fear of a shut down or bad accident at a time we need to evacuate due to a hurricane barreling up the coast. Please also NEVER do repairs during hurricane season!!
64	Private Citizen	Yes	12/15/2018	Website						X																					Leave current bridges in place, build 2 new ones which would create separate bridges for North South divided highway. Old bridges would have half the volume which could give them a longer life.
65	Private Citizen	Yes	12/17/2018	Website															X												I wasn't able to make the meetings but as a citizen I would love to have the opportunity to join the team working on this if possible. I live on high ridge drive which dumps out onto the scenic highway very close to the Bourne bridge. Traffic is horrible because drivers constantly block our intersection. If there would be an opportunity to be more involved please let me know. I know wherever is being worked on and decided will be in the best interest for all both homeowners and tourists and town workers and the army Corp as well.

TABLE OF PUBLIC COMMENTS PRIOR TO DRAFT MRER/EA PUBLICATION

					Comment Subject																										
					ALTERNATIVES						ENVIRONMENTAL CONCERNS								TRANSPORTATION					OTHER							
Comment #	Affiliation	Add to Mailing List (Yes/No)	Comment Date	Comment Type	Favor Replacement	Third Bridge	Tunnel	Fill Canal	MassDOT Alternatives	USACE Alternatives	Water Quality	T&E Species	Fisheries	Climate Change	Historical/Cultural Concerns	Recreation	Noise/Air Quality	Socioeconomics	Traffic Concerns	Transportation Technology	Tolls	Weight Restrictions / Concerns	Marine Transportation Considerations	Evacuation Concerns	Safety Concerns	EIS / NEPA Process	Public Involvement/Communication Concerns	Impacts to Private Property	Timeline of Project	Other	Specific Comments/Questions
66	Private Citizen	Yes	12/17/2018	Website	X	X			X						X																Build two new bridges next to existing ones using EXACT same design except for wider lanes and narrow breakdown lane so that when done, when viewed from the side they would look identical to existing ones and then remove the current ones. A third bridge won't help as no connecting roads. And at some point the existing ones need major repairs that may not be possible.
67	Private Citizen	Yes	12/17/2018	Website			X			X																					Solution idea: We trench out paths for drop in tunnels. How it works: We trench a path that intersects with the canal about 30' deeper than the canal. We put up walls as to not let the trench fill itself in. We drop in 100-200' tubes that hold roadway and lights. Why this is a good idea: Cost effective. The tube sections can be replaced for maintenance or if there were an accident. The possibilities are endless.
68	Private Citizen	Yes	12/18/2018	Website	X														X						X						PLEASE replace these bridges!! The lanes are far too small . It\\'s a gamble every time I drive over them. PLEASE REPLACE THEM - SOON!
69	Private Citizen	Yes	12/19/2018	Website					X	X									X	X											I spoke at the public meeting held at Bourne High School on December 4, 2019. One of my key points was a suggestion that we, collectively, explore innovative solutions outside basic bridge replacement. I pointed out that technology is impacting, and will continue to impact, how we deal with functional challenges around us. I recommend that the Army Corps and MASSDOT explore automated car management to load the new bridges with traffic. Imagine kiddie car rides at amusement parks. By momentarily taking control of cars approaching the bridges (electronically or physically) we could develop a system that loads the traffic at a constant speed and in close physical proximity. This approach would also help manage the merging of traffic at constant speeds and again in close physical proximity. There is much to be learned from manufacturing and production line technology, automation, and speed control. I would be happy to brainstorm this idea with appropriate Army Corps personnel.
70	Private Citizen	Yes	12/19/2018	Website	X													X													I strongly support the construction of new modern bridges over the Cape Cod Canal. To do anything else would be a major waste of resources and would negatively affect future generations of Cape Cod residents and small businesses.
71	Private Citizen	Yes	12/19/2018	Website			X																								Please consider a feasibility study of tunnels.

TABLE OF PUBLIC COMMENTS PRIOR TO DRAFT MRER/EA PUBLICATION

Comment #	Affiliation	Add to Mailing List (Yes/No)	Comment Date	Comment Type	Comment Subject																										Specific Comments/Questions
					ALTERNATIVES						ENVIRONMENTAL CONCERNS								TRANSPORTATION					OTHER							
					Favor Replacement	Third Bridge	Tunnel	Fill Canal	MassDOT Alternatives	USACE Alternatives	Water Quality	T&E Species	Fisheries	Climate Change	Historical/Cultural Concerns	Recreation	Noise/Air Quality	Socioeconomics	Traffic Concerns	Transportation Technology	Tolls	Weight Restrictions / Concerns	Marine Transportation Considerations	Evacuation Concerns	Safety Concerns	EIS / NEPA Process	Public Involvement/Communication Concerns	Impacts to Private Property	Timeline of Project	Other	
72	Private Citizen	Yes	12/19/2018	Website	X													X							X						Having gone over these bridges for 60 years, the danger factor has increased to the point of replacement. I travel across the bridges at least 3 times per week, over and back, and I have never once crossed without being concerned for my safety. Those of us who know the bridge are cautious. It's those who are unfamiliar and those who are simply bad drivers that make the crossing perilous. REPLACE the BRIDGE in my lifetime, please. For safety, for the Cape economy, for ensuring that the Cape's tourism economy can be sustained. Thank you!
73	Private Citizen	Yes	12/19/2018	Website			X										X	X	X												Tunnels to replace both bridges that travel onto and off of Cape Cod. Replacements of bridges would be nice, but ugly. To many Americans live on Cape Cod, and exposed ground needs to be thought of first. A third tunnel could handle train traffic as well. Yet having Cape Cod canal as it was with just bridges for trains heading onto and off of Cape Cod is a more important view to consider. Especially with the pollution which increases every year with the sociability of Cape Cod growing thanks to tourism and residents. Now that's a very good vision to think a few times dealing with tunnels and train bridges.
74	Private Citizen	Yes	12/19/2018	Website	X					X																					The Cape needs two (or maybe three) new bridges. It is a waste of time and money to try and repair them.
75	Private Citizen	Yes	12/20/2018	Website		X		X	X	X								X	X												As a relatively new wash ashore, I find the notion of filling in the canal to be absolutely appalling. I also find the idea of a third bridge to be untenable. The Cape offers slower pace of life. Finding ways to allow more and more people to come and clog up the beaches and roadways seems counter productive to that very lifestyle. I trust that there are engineering break throughs that will allow the Corps and MassDOT to design safe, efficient and environmentally sound bridges that maintain the essence of Cape Cod. Do not let the almighty tourism dollar ruin this most beautiful place.
76	Private Citizen	Yes	12/21/2018	Website																							X				Please add me to your mailing list. Also, consider social media posts. Thank you.
77	Private Citizen	Yes	12/21/2018	Website				X																							The Canal is obsolete, fill it in from the Sandwich Basin to Mass maritime.
78	Private Citizen	No	12/22/2018	Website				X																							There is little need for the actual canal, so it would be much easier and cheaper to fill in the canal.

TABLE OF PUBLIC COMMENTS PRIOR TO DRAFT MRER/EA PUBLICATION

					Comment Subject																										
					ALTERNATIVES						ENVIRONMENTAL CONCERNS								TRANSPORTATION					OTHER							
Comment #	Affiliation	Add to Mailing List (Yes/No)	Comment Date	Comment Type	Favor Replacement	Third Bridge	Tunnel	Fill Canal	MassDOT Alternatives	USACE Alternatives	Water Quality	T&E Species	Fisheries	Climate Change	Historical/Cultural Concerns	Recreation	Noise/Air Quality	Socioeconomics	Traffic Concerns	Transportation Technology	Tolls	Weight Restrictions / Concerns	Marine Transportation Considerations	Evacuation Concerns	Safety Concerns	EIS / NEPA Process	Public Involvement/Communication Concerns	Impacts to Private Property	Timeline of Project	Other	Specific Comments/Questions
79	Private Citizen	Yes	12/23/2018	Website				X	X	X						X			X				X		X						I have lived for 20+ years in walking distance to the Sagamore Bridge. The traffic jams are a dangerous nuisance and the recreation potential is much under exploited. The bridges are technologically obsolete in design with perpetual corrosion issues evolving to structural issue. I suggest a major redesign of the entire canal - perhaps replacing both bridges with smaller lower structures and necking down a central portion of the canal to accommodate standard barge traffic as the largest vessels permissible. The days of sailing ships grounding on outer cape shoals are over. Let us conceive of and build an enduring design to serve our community for many years into the indefinite future.
80	Private Citizen	Yes	12/28/2018	Website																										X	I own a video production company, Hawk Visuals, out of Plymouth and we also engage in drone content. I was wondering if you would be interested in having a conversation as to how I can help with the Cape Cod Canal Highway Bridges MRE Study. I would be happy to communicated via email or feel free to give me a call here in my office at 508-317-9276. Thank you very much for your time! -Matt www.hawkvisualsmedia.com
81	Private Citizen	Yes	1/4/2019	Website					X							X			X						X		X				• Work with State Highway Division to put in place alternating inbound/outbound slower Speed Limits in peak months at least X miles out on either side of the bridges from current limit to 45. The goal is to slow traffic far ahead of bridges to reduce logjams. • Include "Estimated Time to Bridge is X" signs to keep drivers up to date. • A public information campaign will be needed for at least the first year so the public knows what to expect • Suggests the bridges include bicycle lanes. Acknowledges that space is limited but notes that there are other bridges that have this feature and are in more densely populated, busier areas • The road surface of the bridges should absolutely be comprised of materials which will required the least amount of hazardous -to-the-environment chemicals during inclement weather while also being average cost of for future repairs and maintenance.
82	Private Citizen	Yes	1/6/2019	Website					X	X						X	X		X	X					X						• Place large overhead signs on the bridges "Caution: reduce speed, narrow lanes" • Build elevated sidewalks/ bike paths over the side of the bridges. These would require less structural support and would free up space to widen the lanes. • If a new bridge is built over the canal it could be for high speed elevated Electric monorail trains similar to what is used in Disneyland. This would reduce the number of vehicles crossing and air pollution from exhaust. The state already owns the land adjacent to route 3 so the trains could run alongside the highway. Commuter lots would need to be expanded or built. The number of stops along the line would be spaced to allow for passengers to enter or exit, without causing a major increase of trip time completion.

TABLE OF PUBLIC COMMENTS PRIOR TO DRAFT MRER/EA PUBLICATION

					Comment Subject																											
					ALTERNATIVES						ENVIRONMENTAL CONCERNS								TRANSPORTATION					OTHER								
Comment #	**Affiliation**	**Add to Mailing List (Yes/No)**	**Comment Date**	**Comment Type**	**Favor Replacement**	**Third Bridge**	**Tunnel**	**Fill Canal**	**MassDOT Alternatives**	**USACE Alternatives**	**Water Quality**	**T&E Species**	**Fisheries**	**Climate Change**	**Historical/Cultural Concerns**	**Recreation**	**Noise/Air Quality**	**Socioeconomics**	**Traffic Concerns**	**Transportation Technology**	**Tolls**	**Weight Restrictions / Concerns**	**Marine Transportation Considerations**	**Evacuation Concerns**	**Safety Concerns**	**EIS / NEPA Process**	**Public Involvement/Communication Concerns**	**Impacts to Private Property**	**Timeline of Project**	**Other**	**Specific Comments/Questions**
83	S.M.A.R.T.	Yes		Written		X				X									X										X	X	• Access ramps should be addressed - NOW. Existing bridges should be maintained for local non-truck traffic after third bridge is built. • New bridge with access to main highways and exits and entrance ramps away from canal congestion. • Route Vineyard trucks to New Bedford. • Upgrade Bourne rotary and access ramp to Route 25 North from scenic highway NOW - this cannot wait for new bridge (see comment card for diagram and map)
84	Private Citizen	Yes	12/13/2018	Written	X																				X		X		X		• Attended Hyannis meeting as a private citizen and frequent bridge user • Why was there a lack of publicity for the five informational meetings? • Why is such a long and lengthy study needed? It is well known the 83 year old bridges are functionally obsolete and are in an unsafe condition • Why does the USACE not understand that 2 modern and safe bridges are needed NOW? • Why can't the replacement design planning begin now? THE NEED IS CLEAR • Until new bridges are constructed and in use, Cape Cod will be held hostage by Sagamore and Bourne Bridges.
85	Private Citizen	Yes	12/12/2018	Written		X			X	X									X												• The federal government should extend Route 25 over the Bourne Bridge through the air force base, over to around exit 2 of Route 6. This would help with traffic on Route 6, which can be backed up to exit 6 on summer/holiday Sundays. • To alleviate traffic on Route 6, another bridge should be built by Route 6A on CC, because current Route 6A traffic goes over the Sagamore Bridge. This would take cars off the Sagamore Bridge, which is the more congested between the two bridges.
86	Woods Hole Community Association board member	Yes	12/5/2018	Written						X									X			X			X						Present at Bourne presentation and two points that were made were: 1) Large trucks take up two lanes, causing safety concern and traffic. 2) If old bridges remain, there may need to be weight limits on truck traffic. In talking with other groups and evaluating needs, other options to travel to the Vineyard, especially truck traffic, should be encouraged. Currently potential exists to divert traffic (especially trucks) through New Bedford if possibilities are developed. This would address long term needs rather than just short term needs for bridge use. Would be a win-win for all involved.

TABLE OF PUBLIC COMMENTS PRIOR TO DRAFT MRER/EA PUBLICATION

					Comment Subject																										
					ALTERNATIVES						ENVIRONMENTAL CONCERNS								TRANSPORTATION					OTHER							
Comment #	Affiliation	Add to Mailing List (Yes/No)	Comment Date	Comment Type	Favor Replacement	Third Bridge	Tunnel	Fill Canal	MassDOT Alternatives	USACE Alternatives	Water Quality	T&E Species	Fisheries	Climate Change	Historical/Cultural Concerns	Recreation	Noise/Air Quality	Socioeconomics	Traffic Concerns	Transportation Technology	Tolls	Weight Restrictions / Concerns	Marine Transportation Considerations	Evacuation Concerns	Safety Concerns	EIS / NEPA Process	Public Involvement/Communication Concerns	Impacts to Private Property	Timeline of Project	Other	Specific Comments/Questions
87	Sandwich Emergency Management Team	Yes	12/7/2018	Written										X		X			X			X									• Attended the meeting in Bourne on December 4th as a long time Sandwich resident and bridge user and appreciates all the information • Frequently walks and bikes along the Canal and has volunteered on projects with the USACE to repaint mileage numbers and construct beehives • Concerned with beach erosion on Town Neck Beach and has written many articles and videos (original letter contains links) • Currently serves on Sandwich Emergency Management Team and has served on several other beach and town committees in the past • Suggests the USACE consider and include in the MRER EA the following issues: 1) Reports from the Coastal Erosion Committee in the study, "Massachusetts Coastal Commission Volume 1" and "Massachusetts Coastal Commission Volume 2 Working Group Reports" (original letter contains links to PDFs) 2) Include impacts from climate change 3) Wider bridges would allow more traffic to pass, however with limited road capacity on the Cape, this could simply shift traffic jams elsewhere; responsible travelers and commuters make plans to avoid traffic now and should continue to do so. 4) Supports use of rotaries as a way to slow traffic. 5) Heavy truck traffic could be restricted to evening hours.
88	Turtle Rock LLC	Yes	12/20/2018	Written																							X	X			Abutter to Sagamore Bridge on the Cape side. Owner and manager of the Christmas Tree Shop property since 1980s, which has been a great asset. With the pending project coming up soon, wants to ensure USACE has property owner/company contact information and is available to discuss any upcoming issues. There have been some other changes to town and state roads for which no prior notice was provided to property owner.
89	Private Citizen	Yes	1/24/2019	Website				X								X		X													What a shame to fill in the canal!! That is a HUGE attraction and we are a resort area!! I want to know when we have meetings! Thank you!
90	Private Citizen	Yes	1/24/2019	Website	X													X	X											X	We don't need to look far to see a recent successful bridge replacement project completed. The State of Rhode Island replaced the Saconnet Bridge with little interruption by constructing a state of the art concrete precast bridge next to the existing bridge and dismantled the old bridge upon completing the new bridge. My opinion, this makes the most sense and limits the impact on the Cape residents and economic vitality of the Cape.
91	OpenChatham.com	Yes	2/13/2019	Website																						X					The website should provide a link to the ACE's regulations for complying with NEPA. There was a story in the Cape Cod Times about a formal agreement between ACE and MassDOT. That information would be helpful for public understanding, and should also be on the website.

TABLE OF PUBLIC COMMENTS PRIOR TO DRAFT MRER/EA PUBLICATION

Comment #	Affiliation	Add to Mailing List (Yes/No)	Comment Date	Comment Type	Favor Replacement	Third Bridge	Tunnel	Fill Canal	MassDOT Alternatives	USACE Alternatives	Water Quality	T&E Species	Fisheries	Climate Change	Historical/Cultural Concerns	Recreation	Noise/Air Quality	Socioeconomics	Traffic Concerns	Transportation Technology	Tolls	Weight Restrictions / Concerns	Marine Transportation Considerations	Evacuation Concerns	Safety Concerns	EIS / NEPA Process	Public Involvement/Communication Concerns	Impacts to Private Property	Timeline of Project	Other	Specific Comments/Questions
					Comment Subject: ALTERNATIVES						ENVIRONMENTAL CONCERNS								TRANSPORTATION					OTHER							
92	Private Citizen	Yes	1/31/2019	Written		X			X	X									X												Believes that a third bridge is key to resolving vehicular traffic problems associated with the Cape Cod Canal. Believes that MassDOT Canal Area traffic study project manager and engineers are "wearing blinders" with regard to assessing a third bridge as a potential solution to traffic issues. Written submission has several pages demonstrating commenter's position that third bridge is best option to resolve traffic issues.
93	Private Citizen	Yes	2/19/2019	Website															X												I am concerned as i live off the road that intersects with rt 6 where the scenic park is. what will happen with us trying to leave our property. today people dont obey the light and block us from leaving home.
	Town of Bourne Assistant Town Administrator	Yes	2/25/2019	Website																										X	Do you have an email notification policy for project updates? I would like my email address added to the list for email notification for project updates. Thank You.
	Private Citizen	Yes	3/21/2019	Website																										X	Please add me to your mailing list. Thank you.
	Private Citizen	Yes	3/21/2019	Website																										X	comment addition by AECOM to add likely email address for previous commenter that provided email address with 3 d's in spelling of last name, which is inconsistent with last name spelling provided by commenter.
94	Private Citizen	Yes	3/22/2019	Website											X				X												I want to see what we have preserved. These iconic bridges serve their purpose, and allow the amount of traffic over that the intersecting roads can handle. To replace them with bigger, etc, will take away from what we pay dearly for and cherish here on Cape. Keep the up and safe. There is a lot worse bridges around this state and country that need attention.
95	Private Citizen	Yes	3/22/2019	Website	X	X			X										X												There is nothing that should be a supprise to anyone, the bridges are getting close to EOL. That said the most sense, and least impact may be to build a 3rd bridge, once complete the other 2 could be fully refurbished or replaced as deemed by MRE. The only concern is the locatoin, Iknow on the cape side, the Mass Military reservation could create access between 28 and 6, the Mainland side could be problematic, the 6A may be sufficient to handle the volume to a central point.
96	Private Citizen	Yes	3/22/2019	Website	X														X						X						I believe the bridges need replacement. We Cape Codders are held hostage every year either for so much traffic, accidents or the constant repairs that go on. We need modern bridges that are larger, taller and can handle the summer traffic. I have been a off Cape commuter for the last 20 years and have seen everything.

TABLE OF PUBLIC COMMENTS PRIOR TO DRAFT MRER/EA PUBLICATION

					Comment Subject																										
					ALTERNATIVES						ENVIRONMENTAL CONCERNS								TRANSPORTATION					OTHER							
Comment #	Affiliation	Add to Mailing List (Yes/No)	Comment Date	Comment Type	Favor Replacement	Third Bridge	Tunnel	Fill Canal	MassDOT Alternatives	USACE Alternatives	Water Quality	T&E Species	Fisheries	Climate Change	Historical/Cultural Concerns	Recreation	Noise/Air Quality	Socioeconomics	Traffic Concerns	Transportation Technology	Tolls	Weight Restrictions / Concerns	Marine Transportation Considerations	Evacuation Concerns	Safety Concerns	EIS / NEPA Process	Public Involvement/Communication Concerns	Impacts to Private Property	Timeline of Project	Other	Specific Comments/Questions
97	Private Citizen	Yes	3/23/2019	Website		X													X					X							I am a 30+ year resident of Sandwich, and have seen a number of these bridge lane closures and repairs taken place. The last time the Sagamore Bridge underwent repair it was an absolute nightmare. I live on the Cape and commute to Boston for work, and therefore directly impacted by these needed periodic repairs. I'm not sure about the feasibility of replacing both the Bourne and Sagamore bridges, and will leave that decision to the experts. My suggestion would be to construct a third bridge first somewhere in between the other two for several reasons. If one of the existing bridges is to be repaired or replaced, traffic could be diverted to this new bridge and hopefully minimizing traffic congestion that occurs, and also the effect on the economy, tourism, commuting and the local gridlock. Another reason for a third bridge is in the event of a local disaster and need for evacuation of the Cape. Just take a look at route 6 on any Sunday afternoon during the summer. I've seen traffic backed up 10, 12 maybe even 15+ miles at times. Combined with all the residents trying to evacuate the Cape at the same time would be disastrous. Perhaps some of the land at the Northern part of the military base could be used to facilitate the approach and construction of the 3rd bridge? Also, a third bridge would allow for traffic redirection and prolonged closing for extensive repairs that may be needed over the years. Just a few suggestions from a concerned resident that wants to find only the best solution to an issue that's been plaguing the Cape for years. Thank you!
98	Private Citizen	Yes	3/24/209	Website	X				X	X									X						X				X		The possibility of head on crashes alone. Is reason enough to improve the safety of the bridges. Wider roadways , along with 3 lanes from on route 3 and route 6 is 30 years late. All talk and no action seems to be the plan. If Massachusetts had pro infrastructure officials?
99	Private Citizen	Yes	5/15/2019	Website																										X	how can I get a 2019 canal tide chart
100	Private Citizen	Yes	6/11/2019	Website															X	X											I am very interested in how any work at the bridges and surrounding area would improve traffic congestion throughout the region. Additional information on future LOS in the area and advance technologies would be great to hear about. Provisions for public transit or carpooling lanes would be far more beneficial than bicycle lanes.
101	Cape Cod Commission	Yes	6/26/2019	Website	X															X											I am in favor of new, wider bridges with local access lanes.
102	Private Citizen	Yes	7/9/2019	Website	X				X										X												Not only do the bridges need to be replaced, the roads leading onto the area also need improvements to alleviate severe traffic congestion.
103	Private Citizen	Yes	7/16/2019	Website	X					X									X						X						The residents and visitors of Cape Cod are in desperate need of Replacement Including Auxillary Lanes. Not only are the bridges unsafe by current standards, they are also insufficient for the traffic volume year round.
TOTAL					28	18	4	8	23	24	0	0	0	3	3	14	3	15	52	7	3	3	9	4	24	5	20	8	14	13	

This Page Intentionally Left Blank

PUBLIC NOTICES

This Page Intentionally Left Blank

US Army Corps of Engineers®
New England District

696 Virginia Road
Concord, MA 01742-2751

Public Notice

In Reply Refer to: Craig Martin
nae-pn-nav@usace.army.mil
Programs & Project Management Division
Date: October 03 2019
Comment Period Closes: November 01 2019

---

30 DAY PUBLIC NOTICE

AVAILABILITY OF DRAFT MAJOR REHABILITATION EVALUATION REPORT (MRER) and DRAFT ENVIRONMENTAL ASSESSMENT (EA) CAPE COD CANAL HIGHWAY BRIDGES BOURNE, MA

Interested parties are hereby notified under provisions of the National Environmental Policy Act of 1969 (NEPA) (implementing regulations in 40 CFR 1500-1508 and 33 CFR 230), that the U.S. Army Corps of Engineers (USACE), New England District, has prepared a draft Major Rehabilitation Evaluation Report (MRER) and accompanying draft Environmental Assessment (EA) for the Cape Cod Canal Highway Bridges, Cape Cod Canal Federal Navigation Project, Bourne, Massachusetts.

Project Description:
The MRER is a decision document which will provide the basis for the Corps to determine the most cost-effective, safe, and practicable alternative for providing critical access across the Cape Cod Canal, a Federal Navigation Project (FNP). The Cape Cod Canal Federal Navigation Project consists of a channel, anchorages and other improvements that have been constructed and maintained by the USACE.

The draft MRER and accompanying EA evaluates alternatives to address component deficiencies of the Bourne and Sagamore bridges which impact their structural and operational reliability. The alternatives include, but are not limited to: continued repair and maintenance of the bridges as needed, perform a major rehabilitation, or replace both bridges with new structures. The MRER includes engineering, cost, economic, and environmental analyses. The Corps will address design and construction considerations and perform additional environmental analyses specific to the recommended plan in the next phase of the project.

Proposed Action:
Based upon recommendations of the MRER, the Corps proposes to replace both the Bourne and Sagamore bridges with new bridges consisting of a total of 4 travel lanes with 2 auxiliary lanes for each. New bridges would be built adjacent to the existing bridges and will incorporate modern safety design standards such as 12-ft. wide travel lanes; appropriate pedestrian and bicycle access

with a separation barrier from vehicle lanes; a median between the two directions of vehicular travel; and shoulders to accommodate vehicle breakdowns. Bridge abutments would be located further north and south of their present locations on each side of the Canal in order to produce approach grades consistent with modern federal highway standards. The existing bridge piers are currently located within the Canal. New bridge piers would be relocated out of the water to the Canal shoreline.

The current bridges would remain open and continue to be inspected and maintained in a safe and reliable state while construction of the new bridges is underway. The current bridges would be dismantled after the new bridges have been opened to traffic.

The actual bridge type, design specifications, and location of new bridges will be determined and evaluated during the design phase of the Cape Cod Canal Bridges Project, which is expected to occur after the MRER is approved.

Environmental Impacts:
The results, as found in the draft EA and Draft Finding of No Significant Impact (FONSI), show that the proposed action would not have a significant adverse impact on the environment. At the conclusion of the public comment period, it is anticipated a FONSI will be signed for the proposed action. An Environmental Impact Statement therefore, is not necessary to implement the Proposed Action for this phase of the Canal bridges project.

Additional Information:
Additional information may be obtained from Mr. Craig Martin, Programs & Civil Project Management Branch, Programs & Project Management Division, at the return address above or by email at nae-pn-nav@usace.army.mil. Copies of the Draft MRER and Draft EA are available online at https://www.capecodcanalbridgesstudy.com/ under the "Documents" tab. Additional copies can be obtained by contacting the Public Affairs Office, 696 Virginia Rd, Concord MA 01742-2751.

Comments are invited from all interested parties and must be submitted via the project website: www.CapeCodCanalBridgesStudy.com or to Craig Martin at the U.S. Army Corps of Engineers, New England District, 696 Virginia Road, Concord, MA 01742-2751, no later than November 1, 2019.

1 OCT 2019
Date

William M. Conde
Colonel, Corps of Engineers
District Engineer

U.S. Army Corps of Engineers
New England District

NOTICE OF 14-Day EXTENSION to PUBLIC COMMENT PERIOD

AVAILABILITY OF DRAFT MAJOR REHABILITATION EVALUATION REPORT (MRER) and DRAFT ENVIRONMENTAL ASSESSMENT (EA)
CAPE COD CANAL HIGHWAY BRIDGES, BOURNE, MA

Interested parties are hereby notified under provisions of the National Environmental Policy Act of 1969 (NEPA) (implementing regulations in 40 CFR 1500-1508 and 33 CFR 230), that the U.S. Army Corps of Engineers (USACE), New England District, has prepared a draft Major Rehabilitation Evaluation Report (MRER) and accompanying draft Environmental Assessment (EA) for the Cape Cod Canal Highway Bridges, Cape Cod Canal Federal Navigation Project, Bourne, Massachusetts.

A Notice of Availability of the Draft MRER and Environmental Assessment was published to the New England District website on October 3, 2019. **Written comments on this draft MRER and EA must now be received by November 15, 2019**.

Project Description:
The MRER is a decision document which will provide the basis for the Corps to determine the most cost-effective, safe, and practicable alternative for providing critical access across the Cape Cod Canal, a Federal Navigation Project (FNP). The Cape Cod Canal Federal Navigation Project consists of a channel, anchorages and other improvements that have been constructed and maintained by the USACE. The draft MRER and accompanying EA evaluates alternatives to address component deficiencies of the Bourne and Sagamore bridges which impact their structural and operational reliability. The alternatives include, but are not limited to: continued repair and maintenance of the bridges as needed, perform a major rehabilitation, or replace both bridges with new structures. The MRER includes engineering, cost, economic, and environmental analyses. The Corps will address design and construction considerations and perform additional environmental analyses specific to the recommended plan in the next phase of the project.

Proposed Action:
Based upon recommendations of the MRER, the Corps proposes to replace both the Bourne and Sagamore bridges with new bridges consisting of a total of 4 travel lanes with 2 auxiliary lanes for each. New bridges would be built adjacent to the existing bridges and will incorporate modern safety design standards such as 12-ft. wide travel lanes; appropriate pedestrian and bicycle access with a separation barrier from vehicle lanes; a median between the two directions of vehicular travel; and shoulders to accommodate vehicle breakdowns. Bridge abutments would be located further north and south of their present locations on each side of the Canal in order to produce approach grades consistent with modern federal highway standards. The existing bridge piers are currently located within the Canal. New bridge piers would be relocated out of the water to the Canal shoreline.

The current bridges would remain open and continue to be inspected and maintained in a safe and reliable state while construction of the new bridges is underway. The current bridges would be dismantled after the new bridges have been opened to traffic. The actual bridge type, design specifications, and location of new bridges will be determined and evaluated during the design phase of the Cape Cod Canal Bridges Project, which is expected to occur after the MRER is approved.

Environmental Impacts:
The results, as found in the draft EA and Draft Finding of No Significant Impact (FONSI), show that the proposed action would not have a significant adverse impact on the environment. At the conclusion of the public comment period, it is anticipated a FONSI will be signed for the proposed action. An Environmental Impact Statement therefore, is not necessary to implement the Proposed Action for this phase of the Canal bridges project.

Additional Information:
Additional information may be obtained from Mr. Craig Martin, Programs & Civil Project Management Branch, Programs & Project Management Division, at the return address above or by email at nae-pn-navAusace.army.mil. Copies of the Draft MRER and Draft EA are available online at https://www.capecodcanalbridgesstudy.com/ under the "Documents" tab. Additional copies can be obtained by contacting the Public Affairs Office, 696 Virginia Rd, Concord MA 01742-2751.

Comments are invited from all interested parties and must be submitted via the project website: www.CapeCodCanalBridgesStudy.com or to Craig Martin at the U.S. Army Corps of Engineers, New England District, 696 Virginia Road, Concord, MA 01742-2751, **no later than November 15, 2019**.

To view/download the subject public notice, please access it on project website listed above.

U.S. Army Corps of Engineers
New England District
696 Virginia Rd.
Concord, MA 01742-2751

MAJOR REHABILITATION EVALUATION STUDY

Cape Cod Canal Bridges

US Army Corps of Engineers ®

How to Participate

What is the purpose of this meeting?

The USACE conducted a multiyear study of the Bourne and Sagamore bridges to determine whether major rehabilitation or replacement of either or both bridges would provide the most reliable, fiscally responsible solution for the future. The existing bridges were constructed 84 years ago and require frequent maintenance, which is costly and causes significant impact to traffic crossing the Cape Cod Canal.

The USACE prepared an Environmental Assessment (EA), as part of the Cape Cod Canal Bridges Major Rehabilitation Evaluation Report (MRER), and in compliance with the National Environmental Policy Act (NEPA), to examine the potential effects associated with the alternatives examined within the MRER and to allow for public involvement in the evaluation process.

What is an Environmental Assessment?

An Environmental Assessment (EA) is required by the National Environmental Policy Act of 1969 (NEPA).

Under NEPA, Federal agencies must consider the impacts of a proposed project or action on the natural and human environment and take this information into account in their decision-making.

Proposed actions that are not anticipated to result in significant impacts are analyzed through an EA rather than a more detailed Environmental Impact Statement (EIS). An EA analyzes the potential impacts of an action in sufficient detail to determine whether there are likely to be significant effects. A Finding of No Significant Impact (FONSI) is issued if the agency determines the proposed action will not have a significant impact to the human environment. The proposing agency may proceed with implementing the action once all analyses have been completed and potential effects thoroughly considered.

How is an EA prepared?

A typical Environmental Assessment involves the following steps:

1. **Public Involvement:** The USACE consults with agencies, federally-recognized tribes, interested groups, and the public to ensure that all important issues are considered.
2. **Preparation of the Draft EA:** A Draft EA is prepared by a team of environmental professionals to address all identified concerns. It describes the proposed action, the alternatives being considered, and the potential impacts of these alternatives on the environment both natural (air, water, vegetation, wildlife, etc.) and human-made (land use, traffic and transportation, noise, community resources, etc.).
3. **Review of the Draft EA:** Once complete, the Draft EA is made available for review and comment. The USACE will hold public meetings when the Draft EA is released.
4. **Preparation of the Final EA:** After comments are received and analyzed, the USACE will prepare a Final EA. The Final EA incorporates and addresses the comments on the Draft.
5. **Publication of the Final EA and Finding of No Significant Impact (FONSI):** If the USACE determines the proposed action will not have a significant impact USACE will prepare a FONSI. The FONSI document is the document in which the USACE announces and explains its decision after having considered the findings of the EA and the comments received. If the USACE determines the action will have a significant impact on the human environment an EIS will be prepared.

What will the USACE do with my comments?

Comments will be collected, reviewed, and considered during drafting of the Final EA. They will be taken into consideration in making the decision as to whether issuing a FONSI is warranted. Although the USACE will not respond to each comment individually, both the Draft EA and the Final EA will be made available to the public.

Is this meeting my only chance to comment?

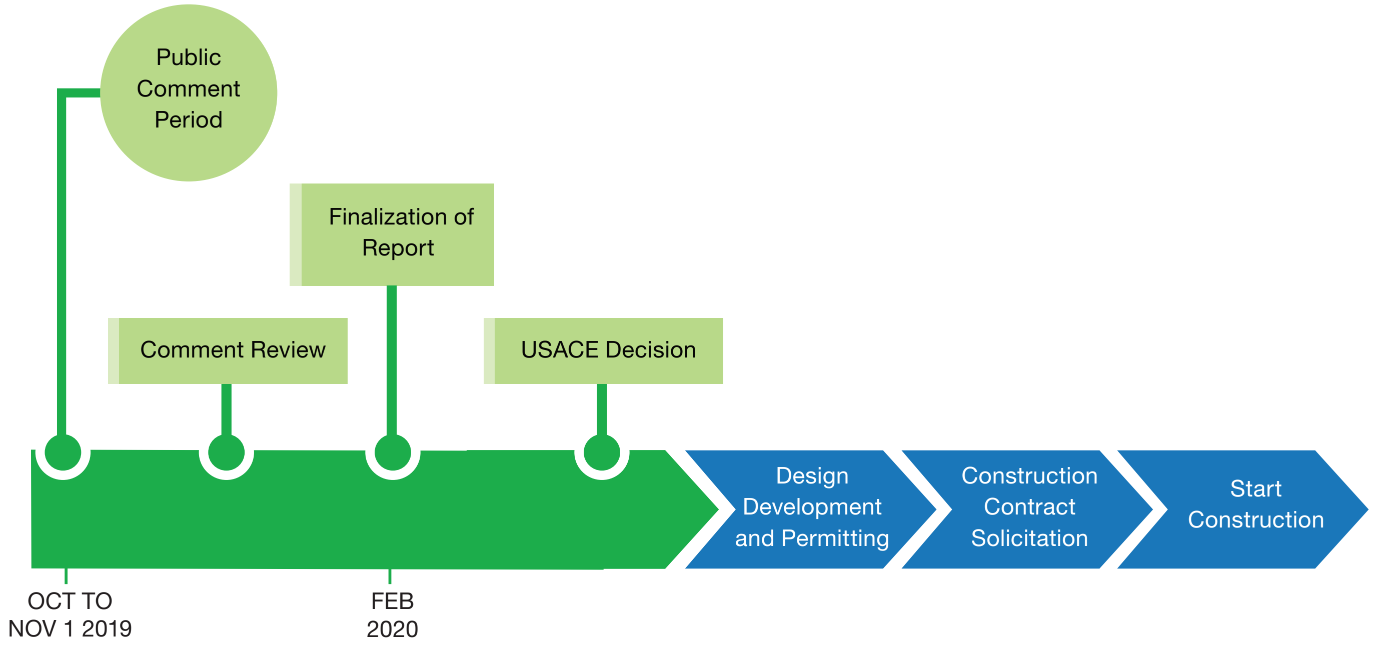
There are multiple ways to submit comments, as identified in the box on this page. All comments received will become part of the Administrative Record and will be published in the final EA.

Ways to Comment

- Voice your comment at today's meeting where a court reporter will record your comment
- Provide written comments at today's meeting
- **Submit comments online via the project website: www.CapeCodCanalBridgesStudy.com**
- Mail written comments to:
  U.S. Army Corps of Engineers
  Attn: Cape Cod Bridges Study NEPA Coordinator
  696 Virginia Road
  Concord, MA 01742

Submit Comments by November 1, 2019

Study Completion Timeline & Next Steps



To learn more about the study, please visit the project website:
www.CapeCodCanalBridgesStudy.com

MAJOR REHABILITATION EVALUATION STUDY
Cape Cod Canal Bridges

US Army Corps
of Engineers ®

Project Overview

Major Rehabilitation Study

The Major Rehabilitation Evaluation Report (MRER) presents the findings of a study examining the alternatives of rehabilitating or replacing the Bourne and Sagamore, bridges, which cross the Cape Cod Canal. The bridges are part of the Cape Cod Canal Federal Navigation Project (FNP) which is operated and maintained by the U.S. Army Corps of Engineers (USACE), New England District (NAE). The Bourne and Sagamore bridges were constructed more than 84 years ago and require frequent maintenance, which is costly and causes significant impacts to traffic crossing the Cape Cod Canal. The USACE completes an MRER whenever infrastructure maintenance construction costs are expected to exceed $20 million and take more than 2 years of construction to complete.

The MRER is based on four pillars of evaluation: a structural engineering risk and reliability analysis of the current structures, cost engineering, economic analysis, and environmental evaluation of all feasible alternatives. An MRER identifies operational and potential reliability issues, as well as opportunities for efficiency improvement, over a 50-year period of analysis.

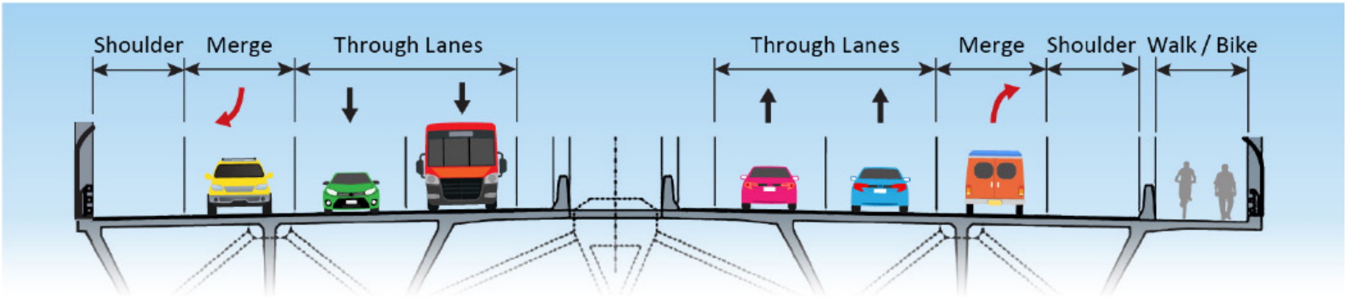
As part of the MRER, the USACE prepared an Environmental Assessment (EA), in compliance with the National Environmental Policy Act (NEPA), to examine the potential effects associated with the alternatives examined within the MRER and allow for public involvement in the evaluation process.

The MRER provides the basis of decision-making for USACE on the most cost-effective, safe alternative for critical public transportation access across Cape Cod Canal for the next several decades.

The MRER is Phase I of the bridges project and will not result in full bridge design and construction details. Additional efforts will be undertaken at the conclusion of the MRER to derive any Congressional authorization necessary leading to a full design and construction of the selected path forward.

Alternatives Analyzed

Numerous alternatives have been proposed for the future of the Cape Cod Canal highway bridges. Public comments were submitted during a series of five informational meetings held in December 2018 and through written comments via the USACE Cape Cod Canal Bridges Project website (www.CapeCodCanalBridgesStudy.com) established specifically for this project. Various methods for new canal crossings were suggested, including new bridges, tunnels, low causeway style bridges and closure of the Canal to navigation with restoration to the pre-Canal road system. These initial alternatives were then evaluated and screened to reduce the list to only those plans, which in terms of likely cost, impacts on the marine and land transportation systems, traffic and environmental impacts, and overall practicability, would be implementable.



Analysis of four alternatives were carried through the Study and accompanying EA for further analysis: (1) No Action (i.e. continued standard maintenance replacing elements as identified through regular inspection); (2) Major Rehabilitation; (3) Bridge Replacement – 4 lanes; and (4) Bridge Replacement - 4 Lanes with 2 Auxiliary Lanes.

The Recommended Plan

The MRER has determined that providing two new highway bridges would be the most **cost-effective** means of providing safe and reliable crossings as the existing bridges are 84-years-old and require frequent maintenance.

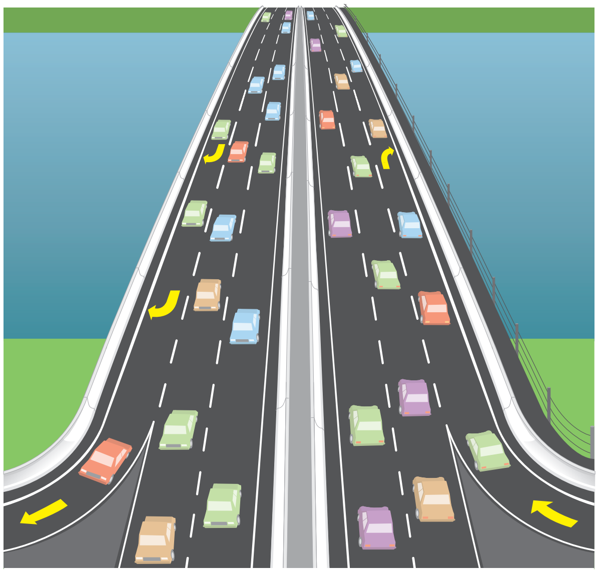
A new high level, fixed span bridge would be constructed immediately adjacent to each of the two existing highway bridges so as to minimize the modifications needed to the connecting roadways on both the mainland and the Cape. The new highway bridges would be designed to include access for both pedestrians and other non-vehicular traffic such as bicycles. To improve traffic safety and through traffic reliability each bridge would include two through traffic lanes and one acceleration/deceleration lane in each direction, for a total of six vehicular lanes on each bridge.

The two existing bridges would remain in operation until the new bridges are opened to traffic. It is anticipated that both bridges would be closed to traffic and demolished once the new bridges are opened.

Partnerships

The USACE is working with Federal and State partners and local stakeholder groups to obtain technical and regional input for all phases of the bridges project. The USACE has entered into a Memorandum of Understanding with the Massachusetts Department of Transportation to continue sharing information and collaborative decision-making regarding the Bourne and Sagamore Bridges and Cape Cod Canal regional transportation infrastructure alternatives into the future.

In addition, the USACE is closely coordinating with the Federal Highway Administration, U.S. Coast Guard, the Environmental Protection Agency, U.S. Fish and Wildlife Service, National Oceanic and Atmospheric Administration's National Marine Fisheries Service, federally-recognized Tribes, several regulatory agencies of the Commonwealth of Massachusetts, and the more than 20 towns in the area.



4-Lane with Auxiliary Lanes Bridge Replacement

To learn more about the study, please visit the project website:
www.CapeCodCanalBridgesStudy.com

Welcome

AGENCY RECOMMENDATION MEETINGS | OCTOBER 2019

How to submit your comments on the Draft MRER Study:

- Voice your comments tonight – sign up to speak at the registration desk
- Submit comments online: www.CapeCodCanalBridgesStudy.com
- Mail your comments by Comment Card also found at the registration desk

MAJOR REHABILITATION EVALUATION STUDY

Cape Cod Canal Bridges

US Army Corps of Engineers®

U.S.ARMY

AGENCY RECOMMENDATION MEETINGS | OCTOBER 2019

MAJOR REHABILITATION EVALUATION STUDY

Cape Cod Canal Bridges

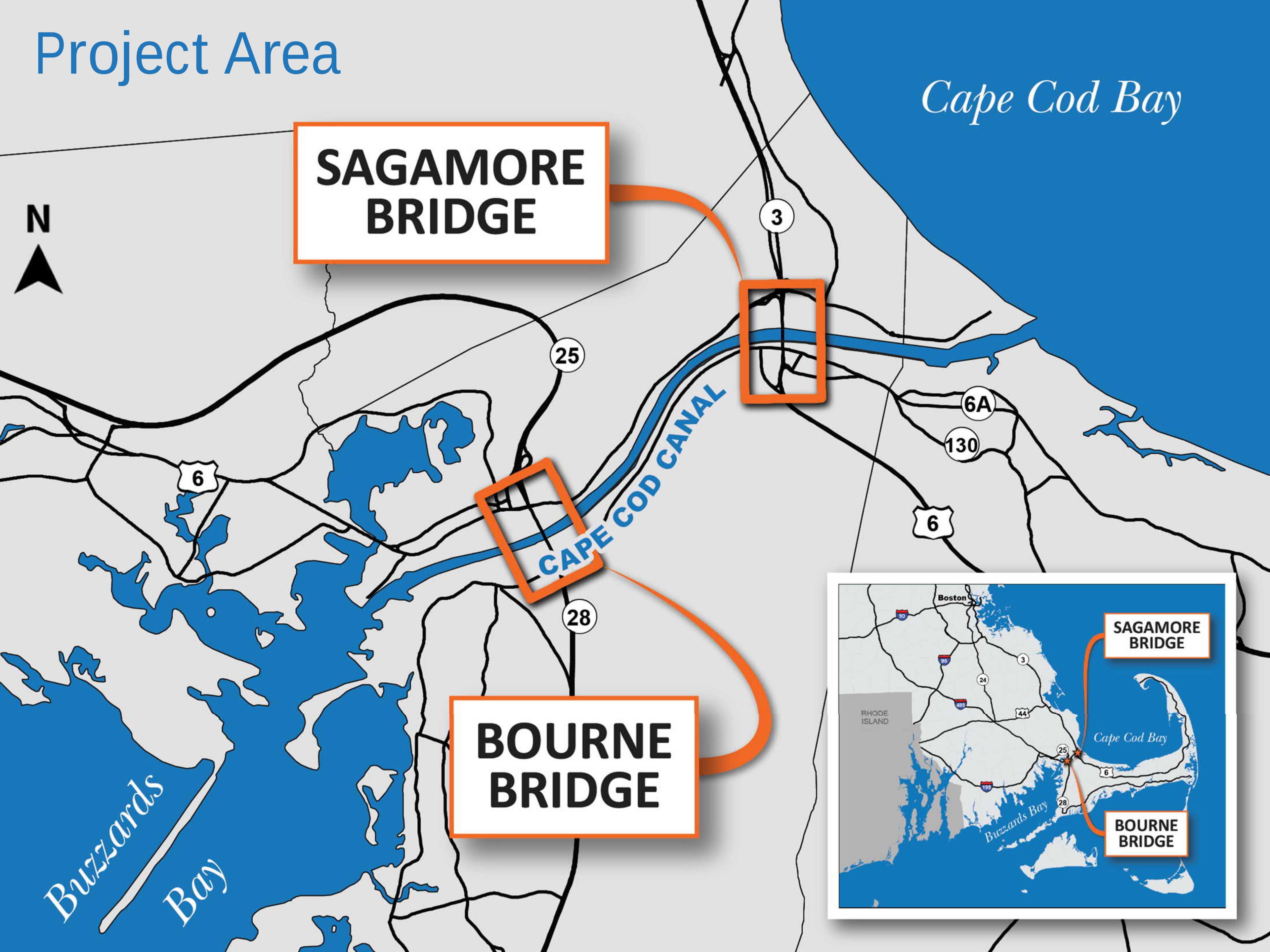
US Army Corps of Engineers®

U.S.ARMY

Today's Agenda

- Existing Conditions
- Major Rehabilitation Evaluation Report and Alternatives
- Summary of Findings
- Recommended Plan
- Timeline and Next Steps
- How You Can Submit Comments

Project Area



Federal Navigation Project Importance to the Region

- Canal Vessel trips (2018)
  - Recreation – 14,320 (est)
  - Large Vessel – 7,460
- Important Ecological Connection
- Recreational Benefits

Operated by the District's Cape Cod Canal Office

Photo credit: RJ Brennick

Bourne & Sagamore Highway Bridges

Built between 1933 and 1935

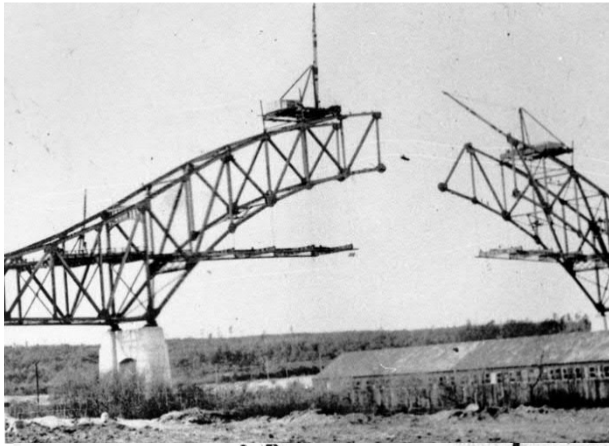
84-year old structures requiring increased maintenance

Approved bridge design funded by Congress:

- Two highway bridges providing access to/from the Cape
- 4 lanes total per bridge; 2 lanes each way
- Abutment to abutment
- No tolls

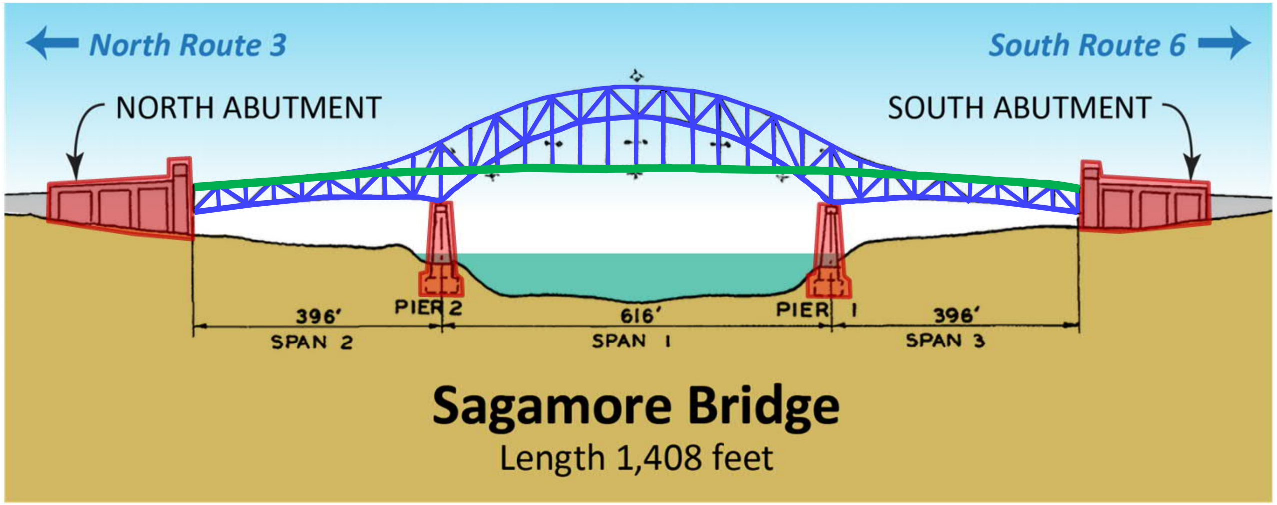
Bourne & Sagamore

Design →	Current
80,000 vehicles Per Month (avg)	3,027,000 vehicles Per Month (10 yr avg)



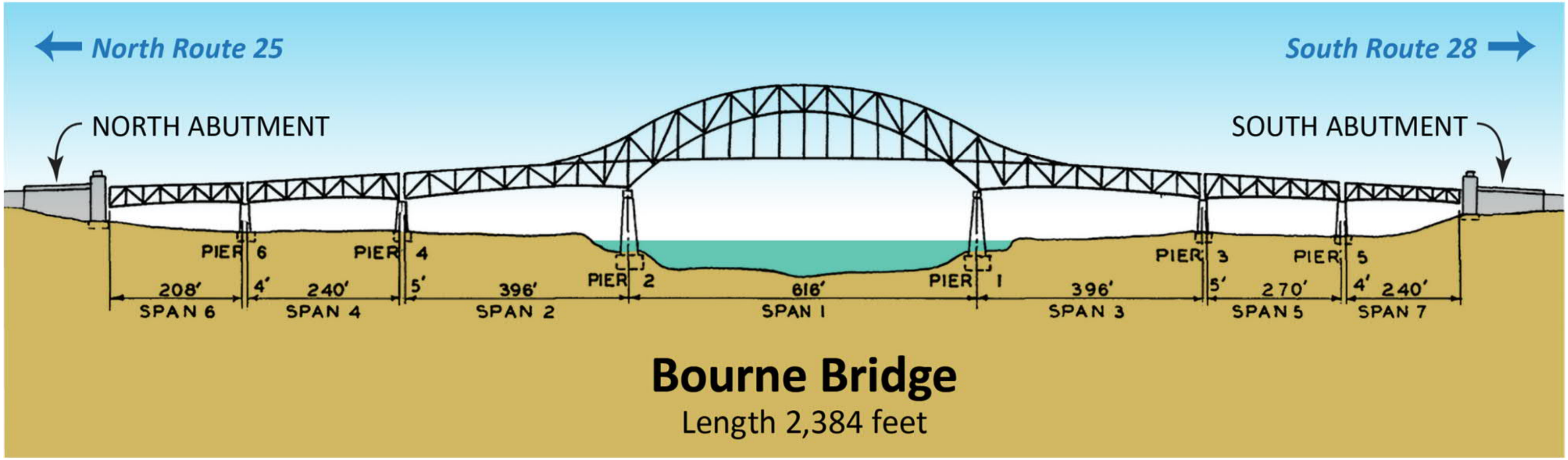
SAGAMORE
BRIDGE
APROACH
SOUTH SIDE
NOV. 1934

Canal Bridges Truss Construction



Sagamore Bridge

Length 1,408 feet



Bourne Bridge

Length 2,384 feet

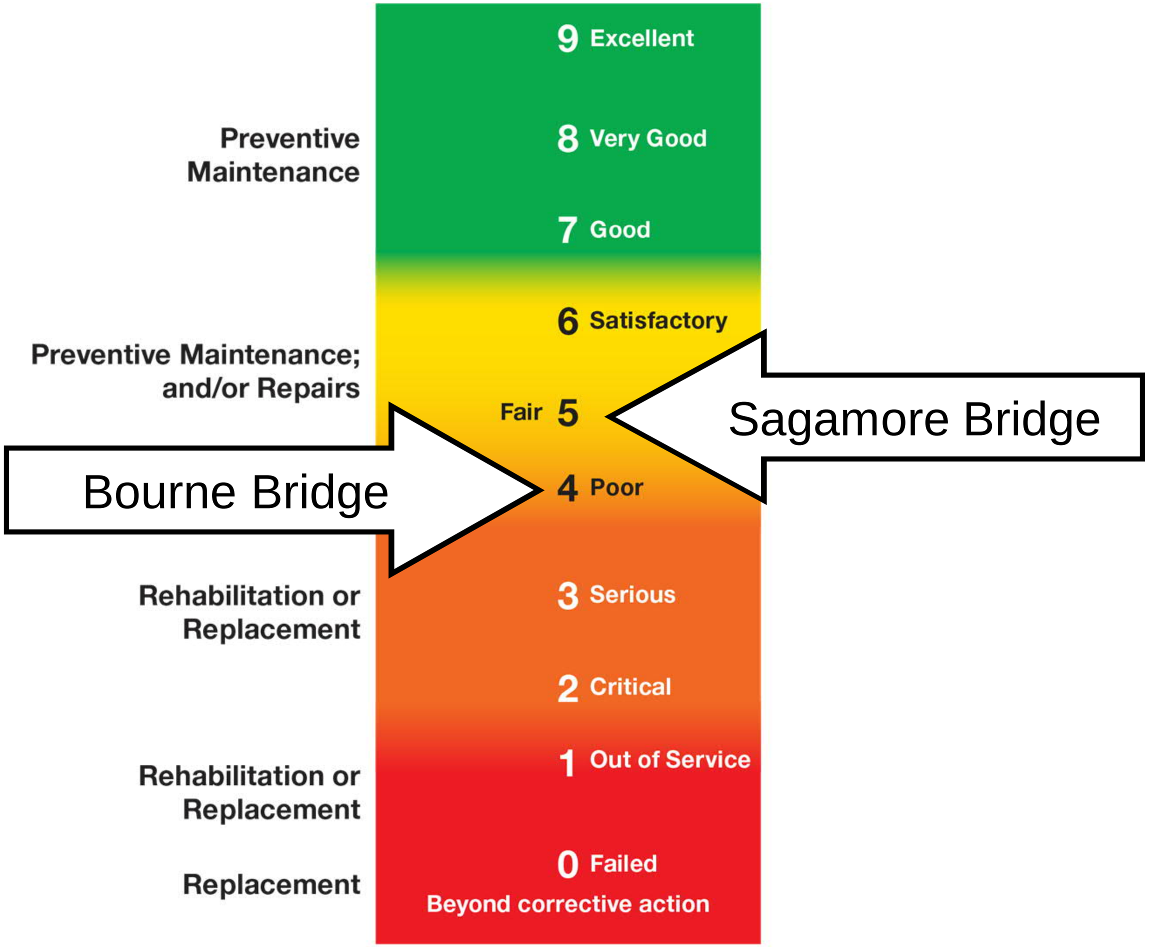
Existing Bridge Conditions

- Full Inspections every 2 years for each bridge
- Maintained to Safe Conditions
- Built to Outdated Standards
  - Narrow lane widths
  - No shoulder lane or median
  - Limited Pedestrian access
- Last Major rehab for both structures 1979-81

CAPE COD TIMES

Existing Bridge Conditions

National Bridge Inspection Standards Condition Ratings



Preventive Maintenance	9 Excellent 8 Very Good 7 Good
Preventive Maintenance; and/or Repairs	6 Satisfactory Fair 5 4 Poor
Rehabilitation or Replacement	3 Serious 2 Critical
Rehabilitation or Replacement	1 Out of Service
Replacement	0 Failed Beyond corrective action

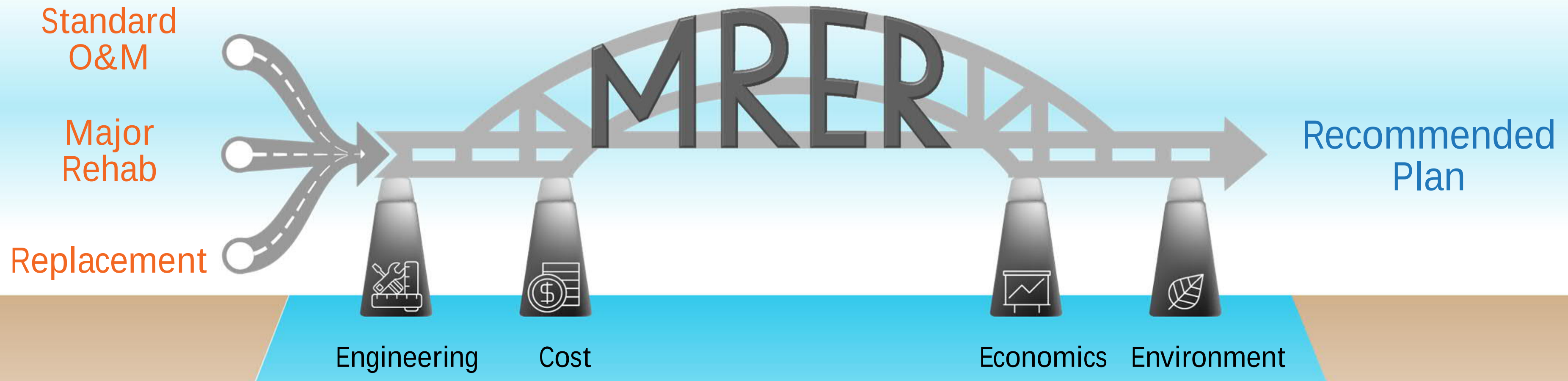
Bourne Bridge

Sagamore Bridge

Bourne Bridge

Sagamore Bridge

The Major Rehabilitation Evaluation Report



Standard O&M

Major Rehab

Replacement

Recommended Plan

Engineering

Cost

Economics

Environment

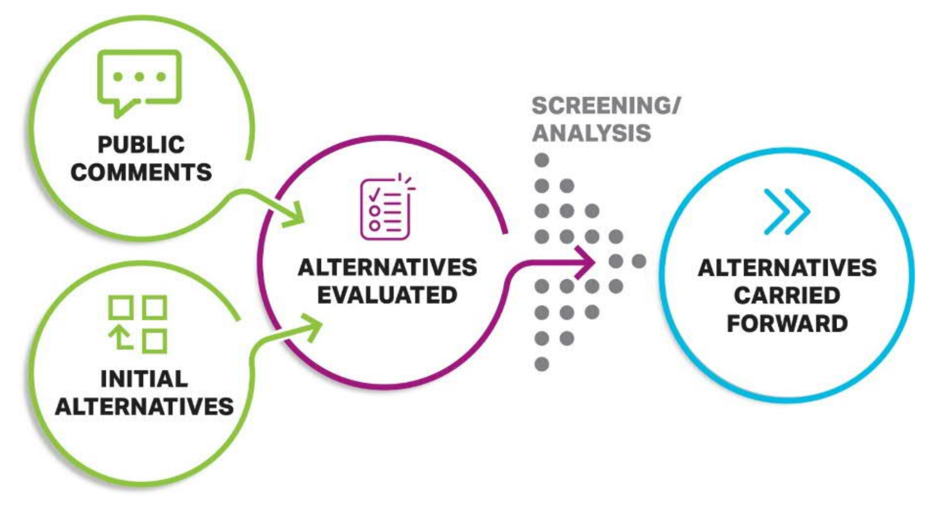
IF anticipated maintenance =

> $20M AND > 2 Years

then

Major Rehab Evaluation
is required

Alternatives Analysis



PUBLIC COMMENTS

INITIAL ALTERNATIVES

ALTERNATIVES EVALUATED

SCREENING/ ANALYSIS

ALTERNATIVES CARRIED FORWARD

Alternatives carried forward for full analysis:

A. Fix-as-Fails / "Without project" (baseline)
B. Major rehabilitation
C. Replacement – 4 Lane
D. Replacement – 4 Lane + 2 auxiliary lanes

Alternatives Not Carried Forward

Third Bridge

Tunnel

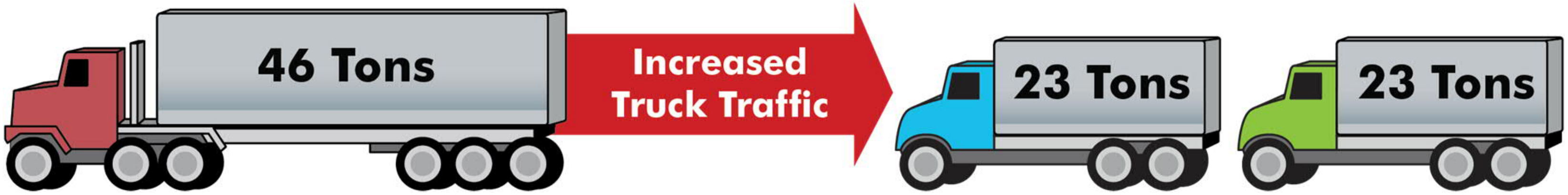
Fill Canal

Low Bridges

ALTERNATIVE - A
Fix-as-Fails / Without Project Baseline

- Involves continued inspection, maintenance and repair of the bridges on “fix-as-fails” basis
- Not a sustainable long-term approach
- Will likely lead to load limitations; posting of bridges

Effect of load limits:



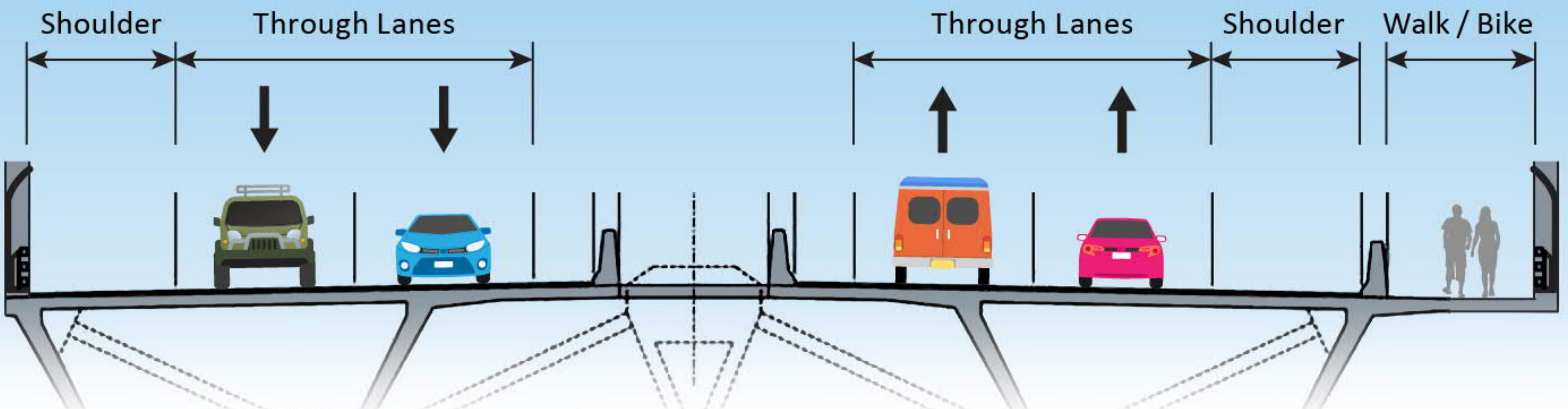
ALTERNATIVE - B
Major Rehabilitation

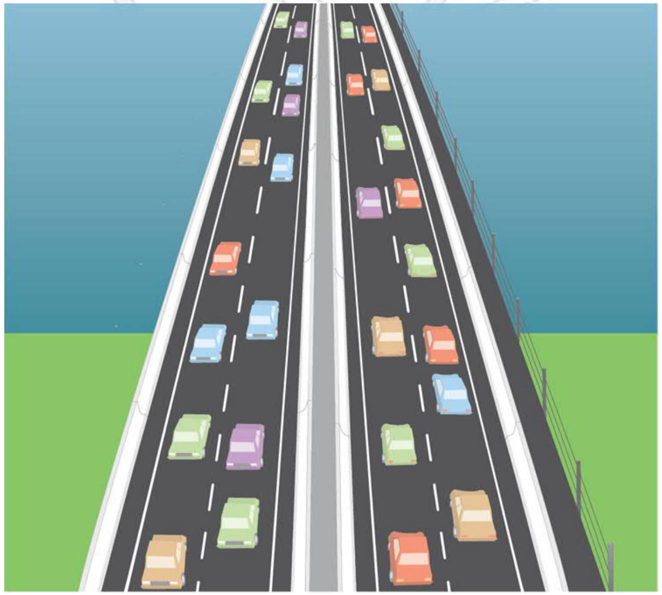
- Repair major components of existing bridges
- Required twice per bridge during next 50 years

BEFORE

AFTER

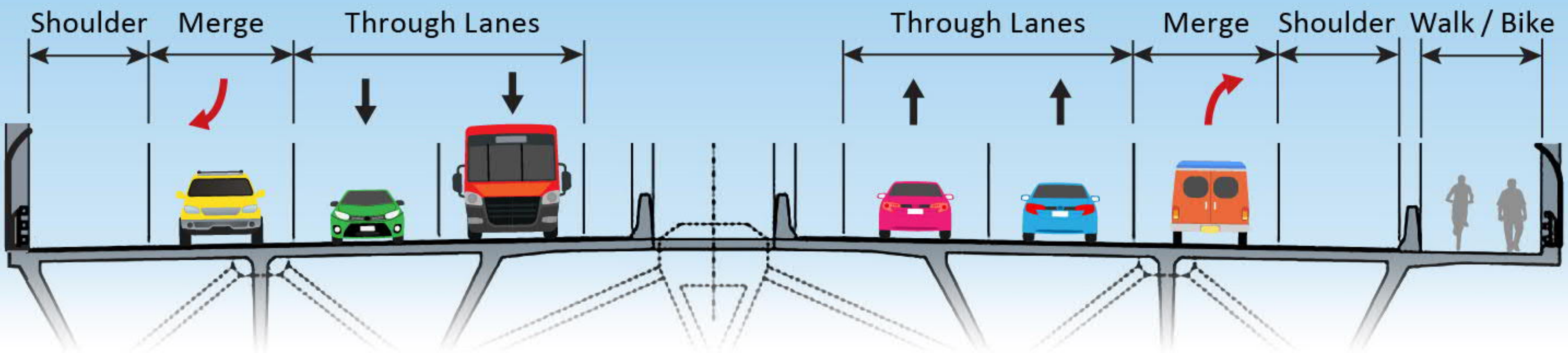
ALTERNATIVE - C
Replacement – 4 Lane

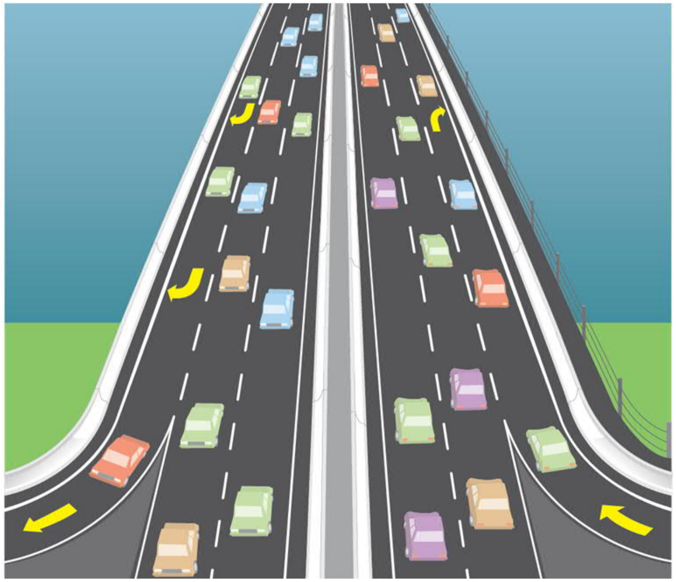




- Designed to modern safety standards
- Matches current bridge layout
- Pedestrian and bicycle access
- Median / shoulders for breakdown lane
- Current bridges remain open until new bridges constructed

ALTERNATIVE - D
Replacement – 4 Lane + 2 Auxiliary Lanes





- Designed to modern safety standards
- Would increase the current bridge layout by 2 lanes for acceleration / deceleration
- Pedestrian and bicycle access
- Median / shoulders for breakdown lane
- Current bridges remain open until new bridges constructed

US Army Corps of Engineers

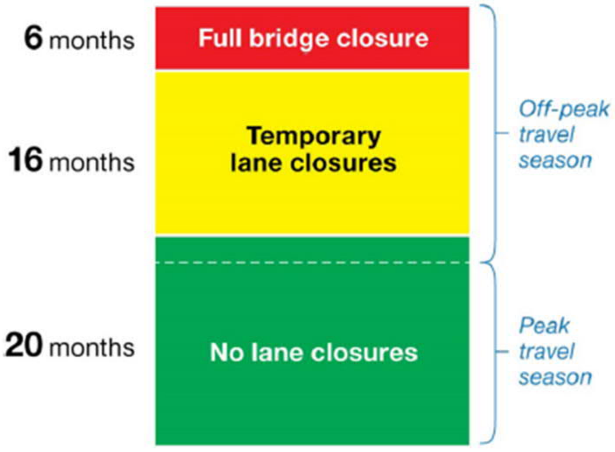
U.S. ARMY

FINDINGS - Engineering

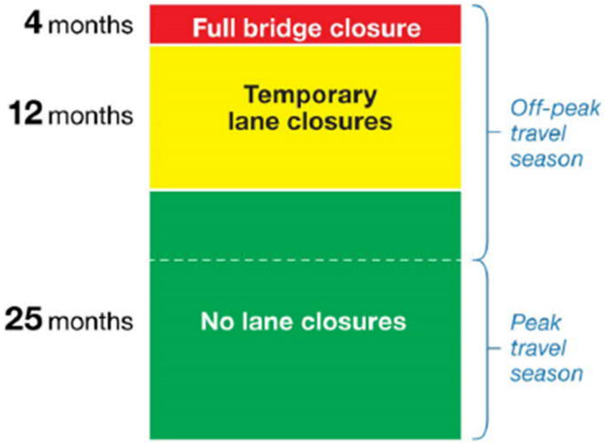
- Conceptual Schedule of Construction Repairs needed to maintain bridges.
- Rehabilitation Construction Period: 3 ½ years per bridge with closures
- Proposed Rehab Construction start (dependent on funding):

  Sagamore: 2025 / Bourne: 2029
- Will require 2 Major Rehabs and numerous O&M events during 50 year project horizon.

3 ½ Year Construction Period



Bourne Bridge



Sagamore Bridge

FINDINGS - Cost Engineering

- Activity / Cost Schedule over the 50 year maintenance horizon developed.
- Full Cost and Schedule Risk Analysis completed for alternatives carried forward.

Total Project Cost Summary 50-YR OPERATIONAL HORIZON	MAJOR REHABILITATION [¥]	REPLACEMENT (4-LANE)	REPLACEMENT (4-LANE + 2 Aux)
Bourne Bridge	$ 817 M	$ 804 M	$ 907 M
Sagamore Bridge	$ 687 M	$ 510 M	$ 567 M
Non-Federal Approaches	$ ----	$ 149 M	$149 M
GRAND TOTAL [*]	$ 1,504 M	$ 1,463 M	$ 1,623 M

[*] Includes PED, LERRs, S&A, Contingency, Utility Relocation, State Approach work, and escalation through mid-point of construction

[¥] 2 Major Rehabs required over 50 year Study period.

FINDINGS - Economics

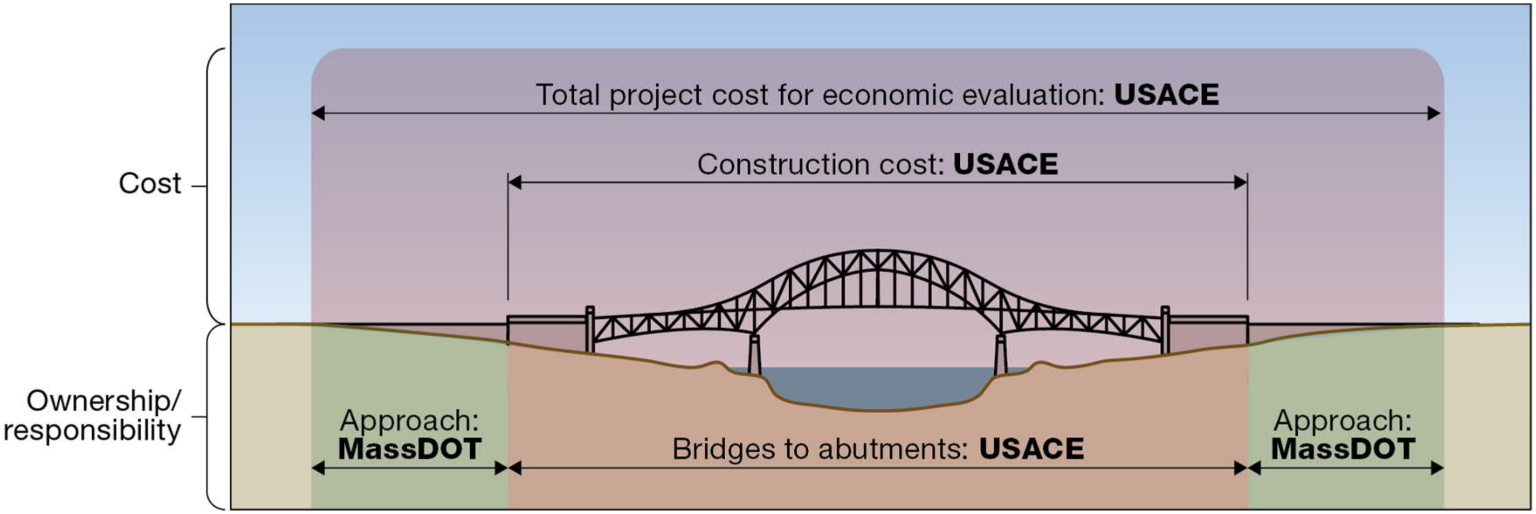
- Analysis compared annual costs to annual net benefits of each alternative over 50 year study period in a risk based approach.
- Incorporated traffic modeling to simulate partial lane & full bridge closures of all alternatives.

Bourne

Benefit to Cost Ratio
Major Rehabilitation: 2.3
Replacement (4 lane): 3.1
Replacement (4+2 lane): 2.8

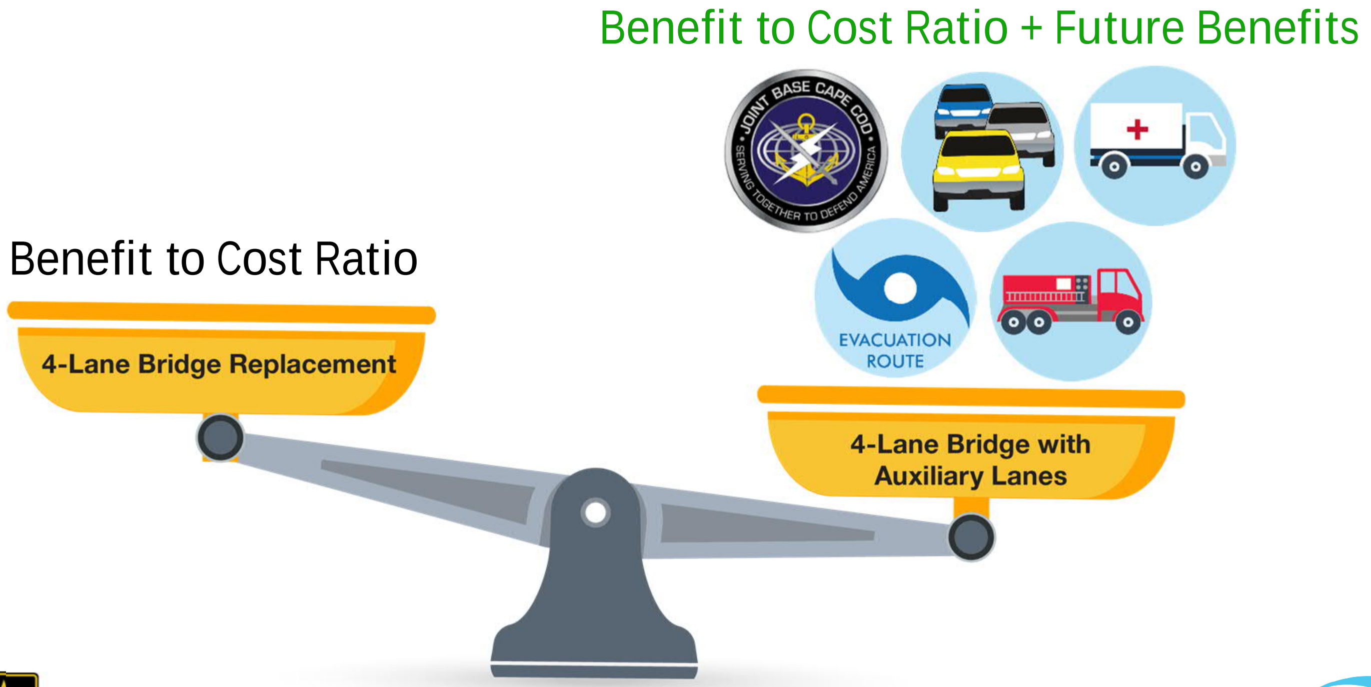
Sagamore

Benefit to Cost Ratio
Major Rehabilitation: 3.2
Replacement (4 lane): 7.7
Replacement (4+2 lane): 7.1


Total project cost for economic evaluation: **USACE**
Construction cost: **USACE**
Cost
Ownership/ responsibility
Approach: **MassDOT**
Bridges to abutments: **USACE**
Approach: **MassDOT**

FINDINGS - Economics

- Other Social Effects - a qualitative analysis suggests additional Future benefits could be gained with incorporation of auxiliary lanes.
- Model assumes no MassDOT improvements other than approach work prior to bridge construction.



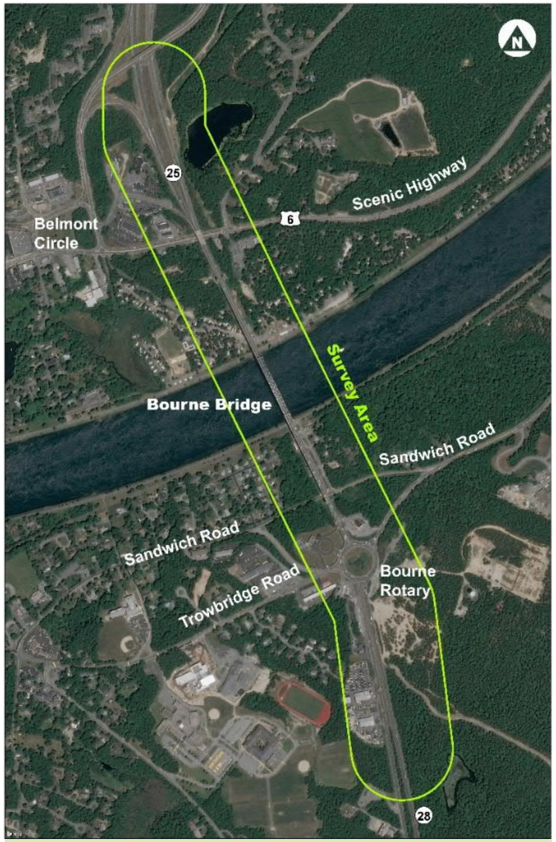
Benefit to Cost Ratio + Future Benefits

Benefit to Cost Ratio

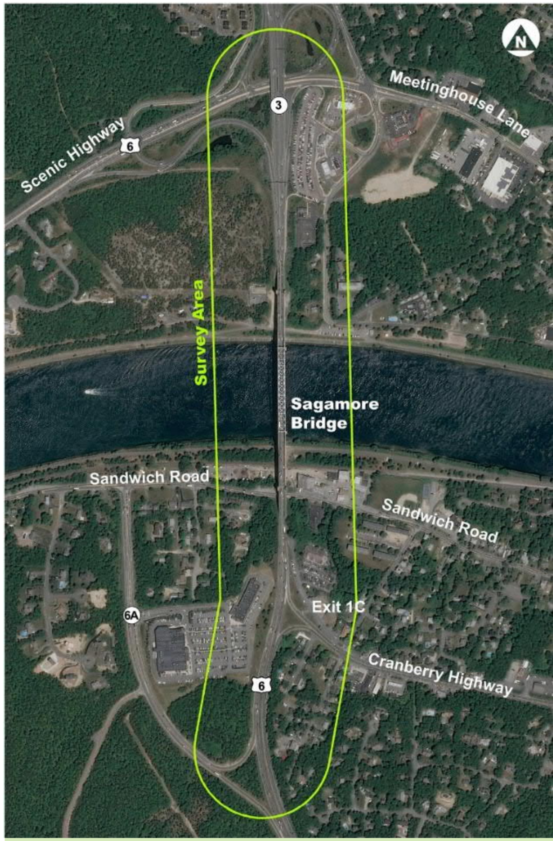
4-Lane Bridge Replacement
4-Lane Bridge with Auxiliary Lanes
JOINT BASE CAPE COD
SERVING TOGETHER TO DEFEND AMERICA
EVACUATION ROUTE

FINDINGS – National Environmental Policy Act

- NEPA undertaken for Rehab vs. Replace Decision (Phase I)
- Evaluates existing environmental conditions and assesses potential impacts to resources
- Coordination with MassDOT & FHWA and Resource Agencies
- Draft EA w/FONSI developed



BOURNE BRIDGE



SAGAMORE BRIDGE

FINDINGS – Environmental

- Project survey area is predominantly developed with existing roadways, homes, and businesses.
- Overall low direct impact to the natural environment for all alternatives.
- Protective measures and use of construction best management practices will mitigate any potential indirect effects of the alternatives.
- Additional environmental analysis will be required in Design (Phase II).

FINDINGS - Historic /Archaeological

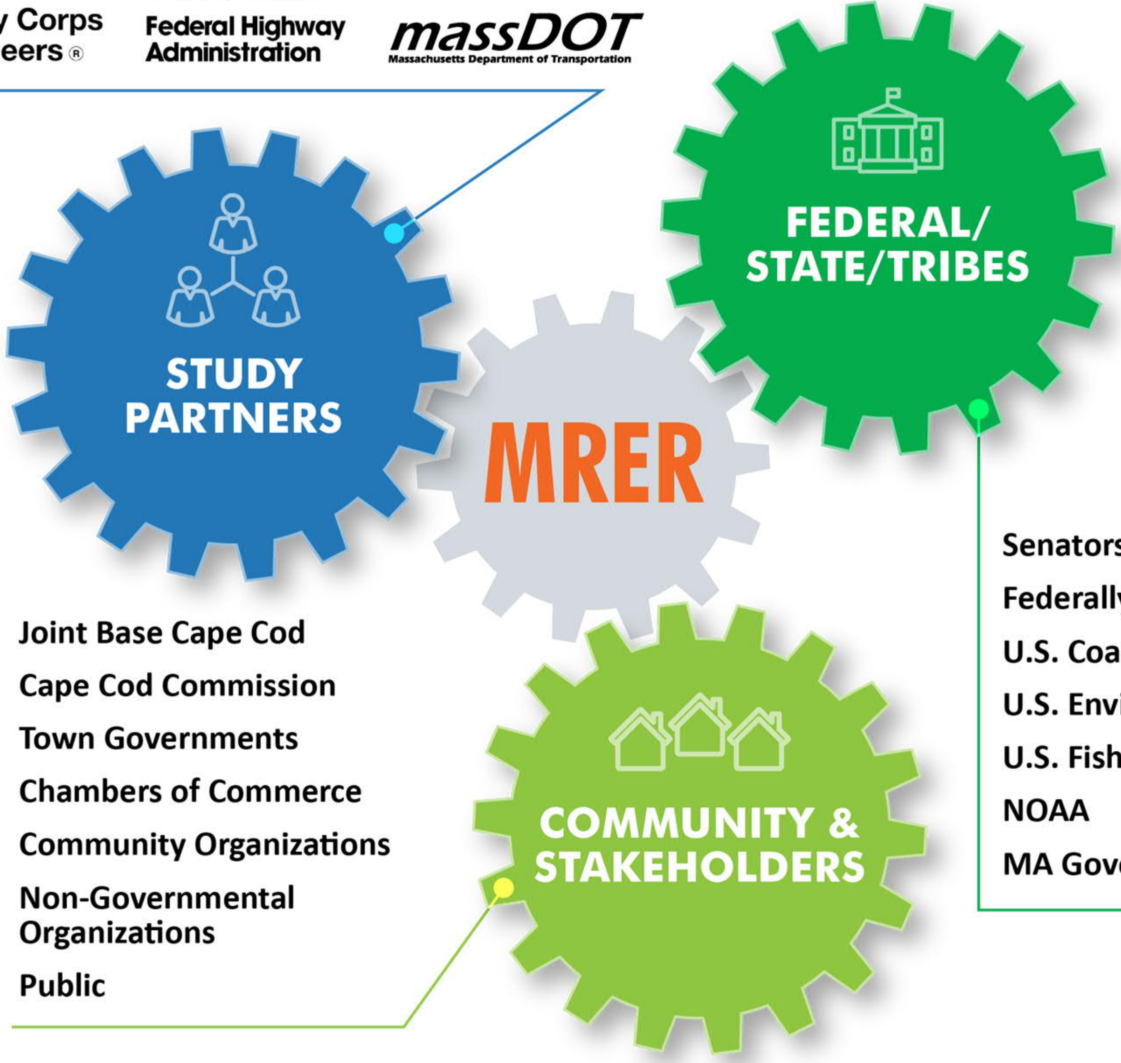
- Both bridges eligible for National Register of Historic Places
- Several historic districts around the bridges; would require viewshed analysis during design
- Two known archeological sites within study area with cultural sensitivity
- Coordination with State Historic Preservation Officer (SHPO) and Tribal Historic Preservation Officers (THPOs) of Federally recognized tribes in next phase of project.

Partnerships for a Successful Outcome

US Army Corps of Engineers

U.S. Department of Transportation
Federal Highway Administration

massDOT
Massachusetts Department of Transportation



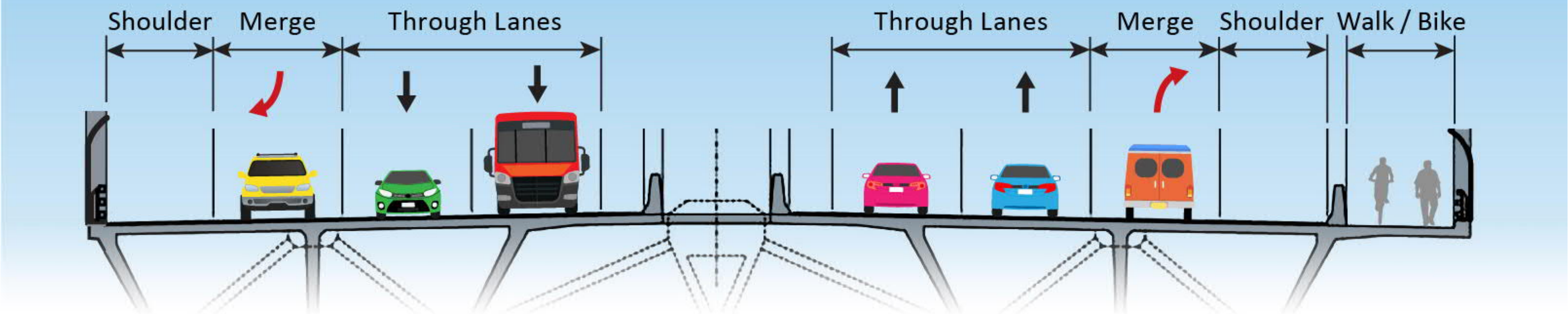
FEDERAL/ STATE/TRIBES

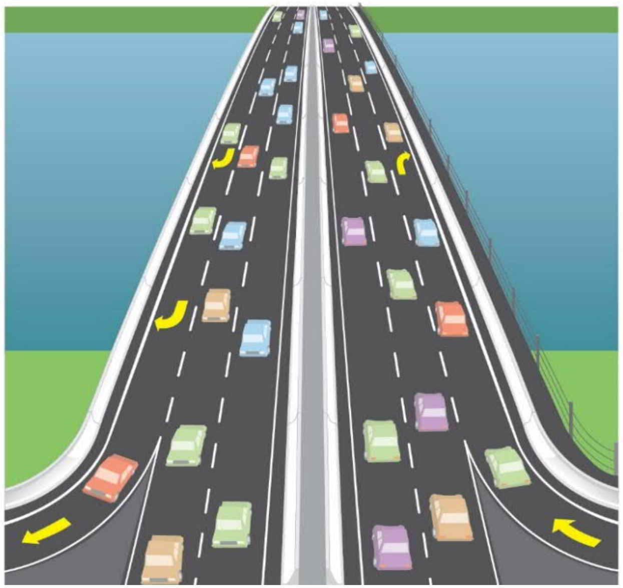
- Senators and Representatives
- Federally Recognized Tribes
- U.S. Coast Guard
- U.S. Environmental Protection Agency
- U.S. Fish and Wildlife Service
- NOAA
- MA Government Agencies

COMMUNITY & STAKEHOLDERS

- Joint Base Cape Cod
- Cape Cod Commission
- Town Governments
- Chambers of Commerce
- Community Organizations
- Non-Governmental Organizations
- Public

Recommended Plan – Alternative D
Replacement – 4 Lane + 2 Auxiliary Lanes

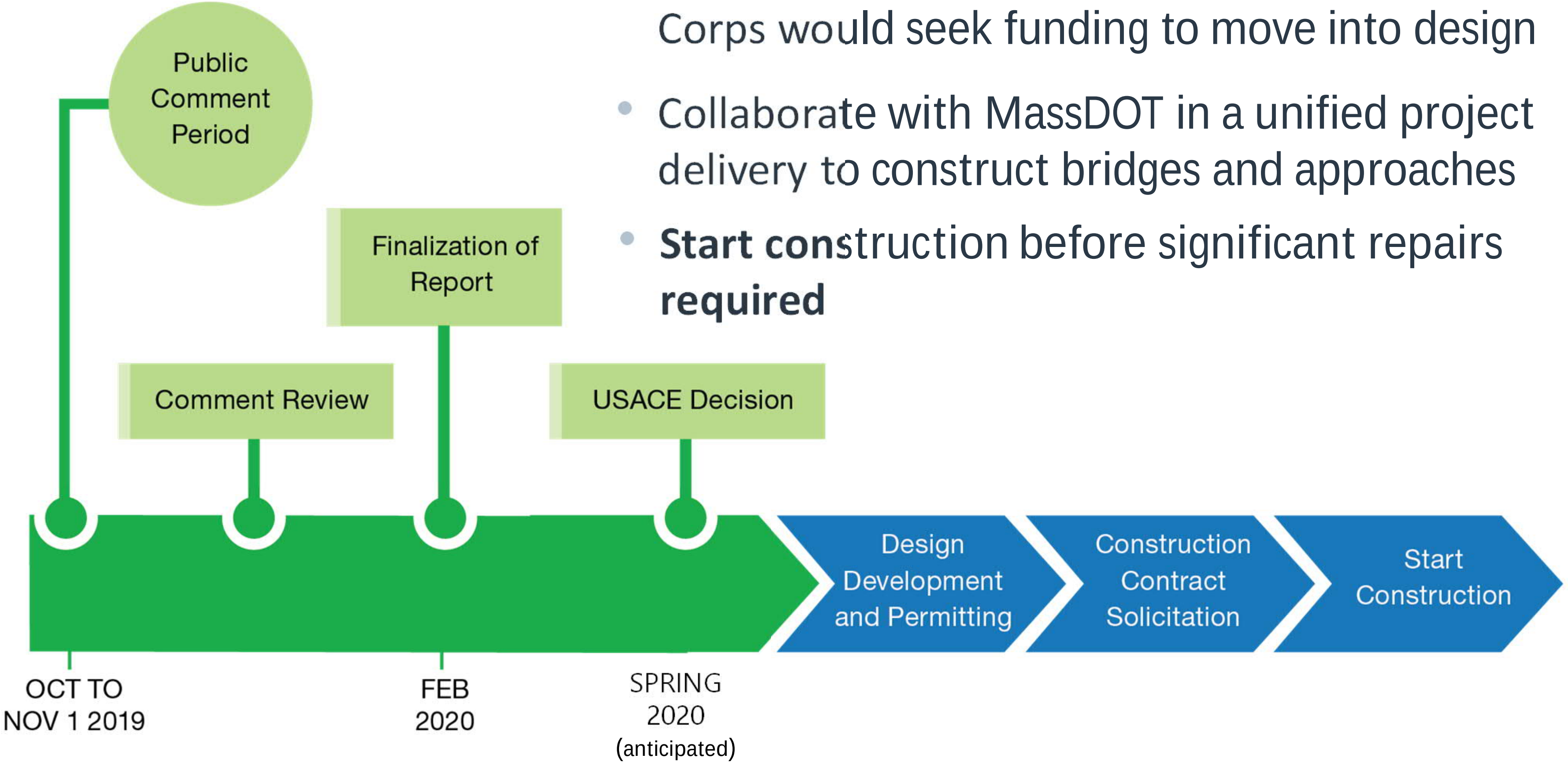




- Most fiscally and environmentally responsible plan for access on/off Cape Cod for the next 100 years.
- Aligns with MassDOT Transportation Study recommendation for improved traffic.
- Will cost approximately $1 Billion dollars in initial construction (FY20 dollars) to build both bridges and require continued collaboration with MassDOT and Federal Highways Administration.

Project Timeline & What Comes Next…

- After a USACE HQ decision is rendered the Corps would seek funding to move into design
- Collaborate with MassDOT in a unified project delivery to construct bridges and approaches
- **Start con**struction before significant repairs **required**



Public Comment Period

Comment Review

Finalization of Report

USACE Decision

Design Development and Permitting

Construction Contract Solicitation

Start Construction

OCT TO NOV 1 2019

FEB 2020

SPRING 2020 (anticipated)

SK44

What Comes Next…

Identify funding & project delivery method

- Selected alternative will require appropriations and may require Congressional authorization

Bridge design and permitting

- Additional public input incorporated during design phase

Initiate Construction

- Construct replacement bridges BEFORE significant repairs are required on existing bridges

Opportunities to comment

Your input is important!

- Your comments at public meetings will be recorded
- Written comments will also be accepted
- 30-Day comment period is open from October 3 to Nov 1, 2019

Q&A Session

Comments due by November 1, 2019

Other ways to submit comments

View Draft MRER Report & Environmental Assessment and submit comments online:

www.CapeCodCanalBridgesStudy.com

Written comments will also be accepted…

Mail comments to:
U.S. Army Corps of Engineers
Attn: Cape Cod Canal Bridges Study NEPA Coordinator
696 Virginia Road
Concord, MA 01742

This Page Intentionally Left Blank

NEWS ARTICLES

This Page Intentionally Left Blank

PUBLIC MEETING/DRAFT EA AVAILABILITY INFORMATION WAS PUBLISHED IN:

DAILY NEWSPAPER
Boston Herald
Boston Globe
Cape Cod Times
Providence Journal (Providence, RI)
Brockton Enterprise
Daily Times Chronicle (Woburn)
Milford Daily News
Metro West Daily News
Patriot Ledger (Quincy)
Springfield Republican
Sun Chronicle (Attleboro)

WEEKLY NEWSPAPER
Martha's Vineyard Times
Vineyard Gazette
Barnstable Patriot
Sandwich Enterprise
Provincetown Banner
Cape Codder
Old Colony Memorial (Plymouth)
The Bourne Enterprise
JI Weekend (Manchester, CT)
Masphee Enterprise
Falmouth Enterprise
The Register (Yarmouth)

WIRE SERVICE
Associated Press
State House News Service

OTHER
Transportation Today

ON LINE
Cape Cod.com
Mass Live
Cape Cod Today
Wicked Local
Cape Cod News
Cape and Islands.org
Cape Cod Online
Patch

RADIO
Bloomberg Radio

WBZ News Radio
WCAI-RM (NPR Cape and Islands)
WGBH-FM

TV
WCVB-TV Boston
WBZ-TV CBS Chan. 4
Boston 25 (Fox)
WWLP-TV (Springfield, Mass.)

PROVINCETOWN BANNER

Date: Thursday, October 10, 2019
Location: PROVINCETOWN, MA
Circulation (DMA): 5,022 (9)
Type (Frequency): Newspaper (W)
Page: A4
Section: Main
Keyword: U.S. Army Corps of Engineers

Weigh in on Cape Cod Canal bridge plans

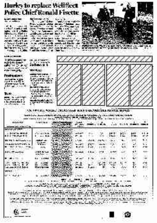
The U.S. Army Corps of Engineers, New England District, will hold five public meetings in mid-October 2019 on Cape Cod, the South Shore and in Boston to provide its recommendation from the Cape Cod Canal Highway Bridges Major Rehabilitation Evaluation Study on the future of the highway bridges spanning the Cape Cod Canal in Bourne, Massachusetts.

"Our recommendation, documented in the draft Major Rehab Evaluation Report, is to replace the Bourne and Sagamore highway bridges with new structures built to include the 4 authorized travel lanes and 2 additional auxiliary lanes designed as acceleration/deceleration lanes built to modern highway standards with appropriate bike/pedestrian access," said District Engineer Col. William Conde, commander of the U.S. Army Corps of Engineers, New England District.

The Draft Major Rehabilitation Evaluation Report (MRER) and Draft Environmental Assessment are available for review on the website at https://www.CapeCodCanalBridgesStudy.com under the "Documents" tab. The Corps will accept public comments on the recommendations in the draft bridge study through Nov. 1, 2019.

Corps public meetings on the MRER bridge study include:

- Wednesday, Oct. 16, 2019, Bourne High School auditorium, 75 Waterhouse Road, Bourne
- Tuesday, Oct. 22, 2019, Nauset Regional High School auditorium, 100 Cable Road, Eastham
- Wednesday, Oct. 23, 2019, Barnstable High School Performing Arts Center, 744 West Main Street, Hyannis



© 2019 PROVINCETOWN BANNER
All Rights Reserved.

For reprints or rights, please contact the publisher

JI WEEKEND (ELLINGTON,S.WINDSOR,STAFFORD)

Date: Sunday, October 13, 2019
Location: MANCHESTER, CT
Circulation (DMA): 35,057 (33)
Type (Frequency): Newspaper (S&S)
Page: 16
Section: Main
Keyword: U.S. Army Corps of Engineers

Cape Cod bridge replacements

The U.S. Army Corps of Engineers has recommended replacing the two narrow and often backed-up bridges that carry vehicular traffic across the Cape Cod Canal. The Corps, which oversees the Bourne and Sagamore bridges, issued a report on the bridges after a study that weighed the advantages of rehabbing the nearly 85-year-old spans versus replacing them entirely. The Corps determined that replacing them would be more cost-effective than paying $1.5 billion to rehabilitate them. The report recommends replacing the four-lane bridges with new wider four-lane structures that include auxiliary acceleration-deceleration lanes, and bike and pedestrian access. Construction could start as early as 2025.

© 2019 JI WEEKEND (ELLINGTON,S.WINDSOR,STAFFORD)
All Rights Reserved.

For reprints or rights, please contact the publisher

JI WEEKEND

Date: Sunday, October 13, 2019
Location: MANCHESTER, CT
Circulation (DMA): 25,496 (33)
Type (Frequency): Newspaper (S&S)
Page: 16
Section: Main
Keyword: U.S. Army Corps of Engineers

Cape Cod bridge replacements

The U.S. Army Corps of Engineers has recommended replacing the two narrow and often backed-up bridges that carry vehicular traffic across the Cape Cod Canal. The Corps, which oversees the Bourne and Sagamore bridges, issued a report on the bridges after a study that weighed the advantages of rehabbing the nearly 85-year-old spans versus replacing them entirely. The Corps determined that replacing them would be more cost-effective than paying $1.5 billion to rehabilitate them. The report recommends replacing the four-lane bridges with new wider four-lane structures that include auxiliary acceleration-deceleration lanes, and bike and pedestrian access. Construction could start as early as 2025.

© 2019 JI WEEKEND
All Rights Reserved.

For reprints or rights, please contact the publisher

SANDWICH ENTERPRISE

Date: Friday, October 11, 2019
Location: FALMOUTH, MA
Circulation (DMA): 3,509 (9)
Type (Frequency): Newspaper (W)
Page: 1,8
Section: Main
Keyword: U.S. Army Corps of Engineers

Draft Army Corps Of Engineers Report Recommends Replacing Canal Spans

By MICHAEL J. RAUSCH

A draft report by the Army Corps of Engineers recommends replacing the Bourne and Sagamore bridges over the Cape Cod Canal.

The Army Corps announced October 3 that its Draft Major Rehabilitation Evaluation Report will recommend replacement of the two aging spans as opposed to continued repairs.

"The USACE has determined that there is sufficient justification for pursuing a program of bridge replacement for both the Bourne and Sagamore highway bridges over the Cape Cod Canal," the report stated.

According to the Corps, the study "has determined that providing two new highway bridges would be the most cost-effective means of providing safe and reliable crossings. The existing bridges are 85 years old and are functionally obsolete."

The Corps owns the bridges, which it built between 1933 and 1935.

Colonel William Conde, commander of the US Army Corps of Engineers for the New England District, said the draft report recommends new structures that will include four travel lanes and two acceleration/deceleration lanes "built to modern highway standards."

The bridges would also be built "with appropriate bike/pedestrian access," the colonel said.

The Corps has scheduled five public meetings this month on the draft report recommendations.

The first will be held next Wednesday, October 16, at 6 PM in the auditorium at Bourne High School. The Corps invites the public to attend and provide input on the draft report.

Replacing the bridges, instead of continuing to repair them, also was the recommendation of MassDOT's Cape Cod Canal Region Transportation Study Group.

The study group issued the results of its five-year study in February.

The existing bridges were constructed 85 years ago. They were built to replace two earlier bridges that had proven to be problematic.

The original Bourne and Sagamore bridges were drawbridges that were electrically operated, and, when opened, provided a 140-foot navigational clearance.

However, the swift current of the canal proved dangerous for vessels waiting for the drawbridges to be opened.

see **Canal Bridges** on Page 8

Fear among mariners led to an underwhelming number of vessels passing through the canal in its first few years, causing it to be deemed a failure.

During World War I, President Woodrow Wilson ordered the canal taken over by the Federal Railroad Administration. After the war, it was returned to the control of original owner August Belmont, but it became apparent that improvements needed to be made to the canal bridges.

In 1928, under authority of the federal Rivers and Harbors Act of 1927, the Army Corps took over operation of the Cape Cod Canal. The Army Corps widened and deepened the canal, and constructed three new bridges: the Bourne and Sagamore vehicular bridges, and the Buzzards Bay railroad bridge.

A Boston Sunday Globe article reported that 1,200 men worked on building the bridges, and roughly 2,000 men worked in the Pennsylvania steel mills, making the pieces used in construction.

Workers were both skilled and unskilled. Skilled laborers earned $1.50 an hour, while unskilled workers made 50 cents an hour.

One of the more significant additions to the bridges was the installation of railing to cut down on the suicides and suicide attempts. In 1977 alone, nine people took their lives jumping from the two bridges. Repeated suggestions to make the bridges safer were made by the Samaritans of Cape Cod, a non-denominational, non-profit volunteer organization that provides emotional support to the lonely, depressed, or suicidal.

In 1981 the Army Corps agreed to install the eight-feet-high railings now in place on the bridges.

In recent years, the Bourne and Sagamore bridges have required increasingly more frequent repair and maintenance, which is costly and causes significant slowdowns for traffic crossing the Cape Cod Canal.

In spring last year the Sagamore Bridge underwent extensive repairs that required lane closures and caused traffic gridlock. News of the work to be done drew a harsh rebuke from Cape Cod Chamber of Commerce CEO Wendy K. Northcross, as well as other chamber members and members of the Cape business community.

That community criticized the Army Corps for scheduling the bridge work during the Cape's shoulder season when businesses are gearing up for the busy summer months. Similar outrage was expressed when repairs and commuter

© 2019 SANDWICH ENTERPRISE
All Rights Reserved.

For reprints or rights, please contact the publisher

snarls were the result of work done on the Bourne Bridge this past spring.

Ms. Northcross and other chamber members have established Coalition for the Fix, an advocacy group lobbying in favor of having the two canal bridges replaced in order to avoid the periodic repairs they say jeopardizes business on the Cape.

Wider bridges will allow for a freer flow of traffic and make it easier for people who live and work on the Cape to get their children to school, or aging parents to a doctor appointment, she said.

"The whole point of the project is to create a more reliable transportation system for Cape residents primarily, but also for visitors," Ms. Northcross said.

Judith M. Froman, chairman of the Bourne Board of Selectmen, suggested that wider lanes might increase the speed at which people travel over the bridges. That, in turn, could be helpful in keeping traffic flowing over the bridges, Ms. Froman said.

Wider bridges, she said, could also mean more room for drivers to react to an unexpected event.

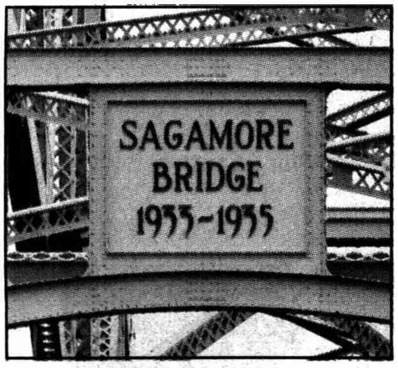
"It is amazing to me how often people slow down to look at the view and they cause accidents," Ms. Froman said. "Maybe we need a viewing tower like at the Penobscot Stonington bridge in Maine."

The Corps said it will accept public comments on the recommendations in the study through Friday, November 1. In addition to next Wednesday's meeting at Bourne High, other Cape meetings will be held: on Thursday, October 17, at Plymouth South High School Performing Arts Center; Tuesday, October 22, at Nauset Regional High School in Eastham; and Wednesday, October 23, at the Barnstable High School Performing Arts Center in Hyannis. Those meetings also begin at 6 PM.

The fifth meeting is scheduled for Monday, October 21, at 1 PM, at the Thomas P. O'Neill Jr. Federal Building on Causeway Street in Boston.

At the end of the public comment period, the Corps will address issues raised by the public. In addition to public comment, the draft report will also undergo an independent external peer review by members of the private and academic sectors, the Corps said.

A final recommendation on whether to replace or continue to repair the Cape Cod Canal bridges will be contained in the final report that will be submitted to Corps headquarters in Washington, DC, in February 2020.



BRENDA M. SHARP/ENTERPRISE

The Sagamore Bridge and the Bourne Bridge were built in a program under President Franklin Roosevelt's New Deal.

© 2019 SANDWICH ENTERPRISE
All Rights Reserved.

CAPE COD TIMES

capecodONLINE.com The Cape and Islands' Daily Newspaper

Date:	Friday, October 18, 2019
Location:	HYANNIS, MA
Circulation (DMA):	19,153 (9)
Type (Frequency):	Newspaper (D)
Page:	4
Section:	Main
Keyword:	U.S. Army Corps of Engineers

Bourne residents question impact of bridge proposals

First hearing on planned replacement of canal spans raises concerns on land-takings

By Ethan Genter
egenter@capecodonline.com

BOURNE — Whatever happens to the Bourne and Sagamore bridges, Bourne stands to be most affected among Cape towns.

About 100 people showed up at Bourne High School on Wednesday night to remind the U.S. Army Corps of Engineers, which was holding the first of five public meetings to talk about its recently released draft report calling for replacement of the two vehicular bridges, of that fact.

"This announcement to potentially — I'm being optimistic — replace the two bridges is an exciting time," said Judith Froman, chairwoman of the Bourne Board of Selectmen. "We want to ensure our 20,000 residents have a significant voice at the table."

She called on the Corps and the Massachusetts Department of Transportation to come to Bourne and meet with the selectmen, even offering up Dec. 3 as a potential date.

"It is now time to have more engagement with Bourne specifically," Froman said.

In the report, released earlier this month, the Corps recommended building two new six-lane bridges adjacent to the existing spans, which would then be torn down. The report is still in its draft form, and Wednesday's meeting was held to get input from the community before it is finalized and the Corps decides what to do.

The Corps said replacing the bridges would be more cost-effective than doing major rehabilitation work on the 84-year-old spans across the canal. But replacement could result in land-takings, a large fear of some of those attending the meeting.

James Poore, who lives and works out of his home near the Sagamore Bridge, worried what would happen to his property.

"It's more than just a home, it's our livelihood," he said. "It's very concerning to me. ... This project is going to impact my life a lot."

Dave Collins, a Sagamore resident who also lives near that bridge, feared what could happen to his and his neighbors' homes if the bridge were to be replaced.

"On the west side, where we happen to live, there is a development of about 15 to 18 houses, and looking at the preliminary design, on the west side, it would take five to six of those houses out and it would be about 50 feet from my front door," he said. "I think a lot of consideration ought to be given to people's homes, (to people) that have lived here for all of their lives, before any decision has been made."

John Doble, a lifelong resident of Bourne, lives on Sandwich Road, right underneath the Cape side of the Bourne Bridge. He had similar concerns.

"How much is my property going to be impacted by this construction of a new bridge?" he asked. "What alternatives do we have?"

The Corps is getting input from the public on whether to rehabilitate or replace the bridges, and any decision on land-takings or on the footprint of the bridges would be considered in the design phase, which has not yet started, said Craig Martin, the Corps' project manager in the New England District.

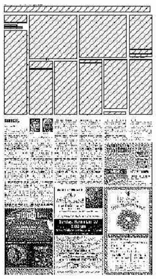
"Once we start the design phase, anyone that might be within the footprint of the potential construction, we are going to bring them in as part of the working group to get their input and notify them of the most up-to-date information," he said.

Others wondered if a third bridge in the middle of the Cape Cod Canal, an idea that has been bandied about for years but was rejected by the Corps in the study, was still a viable option.

The Corps, which is also responsible for the Buzzards Bay Railroad Bridge, is mandated to keep two, non-tolled crossings and said a third bridge was eliminated because of the costs and the amount of work that would be needed to realign a new bridge with local roads.

The state has proposed changes to several roads leading to the bridges and is starting to move into the design phase of some of those projects. Both the Corps and Department of Transportation officials have promised to work together.

"We're going to have a lot of work to do. I understand everybody's concerns. We are going to have a lot more outreach. We are going to work in partnership with the state," said Scott Acone, deputy district engineer for programs and project management in the New England District. "Their transportation study and our rehabilitation are two pieces of a puzzle, and they have to fit together. That's really the only way this is going to help address some of the regional transportation concerns that we have here."



© 2019 Dow Jones Local Media Group, Inc.
All Rights Reserved.

For reprints or reuse, please e-mail sean.polay@dowjones.com or
send a letter to Sean Polay, Dow Jones Local Media Group, Box 580, Middletown, NY 10940

Follow Ethan Genter on Twitter: @EthanGenterCCT.

The Army Corps ofw Engineers will accept public comments on the draft study on the Bourne and Sagamore bridges through Nov. 1. Comments may be submitted at public meetings or online at CapeCodCanalBridgesStudy.com. Written comments may be submitted to U.S. Army Corps of Engineers, New England District, Attn: Craig Martin, 696 Virginia Road, Concord, MA 01742-2751. Comments also may be emailed to nae-pn-nav@usace.army.mil.

Two more hearings will be held on the Cape:

Eastham: 6 p.m. Oct. 22, Nauset Regional High School auditorium, 100 Cable Road

Hyannis: 6 p.m. Oct. 23,

Online

Read more stories about plans for the bridges: capecodtimes.com

More bridge work, hearings

The Bourne and Sagamore bridges will be down to one lane in either direction next week while the U.S. Army Corps of Engineers performs pavement maintenance.

The repairs to the Bourne Bridge will start at 8 p.m. Tuesday and end at 5 a.m. Wednesday.

The Sagamore Bridge work will be done Wednesday into Thursday during the same time period.

Wide loads will not be allowed on the bridge while work is being done.

Public comments

Alan Margraf, of Sagamore, addresses representatives of the U.S. Army Corps of Engineers during a public forum Wednesday at Bourne High School on the proposed replacement of the Bourne and Sagamore bridges. Several area residents expressed concerns about what impact the project could have on their neighborhoods.

Craig Martin, the Army Corps' project manager in the New England District, presents the draft report on the future of the two vehicular bridges over the Cape Cod Canal. [RON SCHLOERB PHOTOS/CAPE COD TIMES]

© 2019 Dow Jones Local Media Group, Inc.
All Rights Reserved.

For reprints or reuse, please e-mail sean.polay@dowjones.com or
send a letter to Sean Polay, Dow Jones Local Media Group, Box 580, Middletown, NY 10940

BOURNE ENTERPRISE

Date: Friday, October 11, 2019
Location: FALMOUTH, MA
Circulation (DMA): 8,738 (9)
Type (Frequency): Newspaper (W)
Page: 1,2
Section: Main
Keyword: U.S. Army Corps of Engineers

TIME TO GO

Draft Army Corps Of Engineers Report Recommends Replacing Canal Spans

By MICHAEL J. RAUSCH

A draft report by the Army Corps of Engineers recommends replacing the Bourne and Sagamore bridges over the Cape Cod Canal.

The Army Corps announced October 3 that its Draft Major Rehabilitation Evaluation Report will recommend replacement of the two aging spans as opposed to continued repairs.

"The USACE has determined that there is sufficient justification for pursuing a program of bridge replacement for both the Bourne and Sagamore highway bridges over the Cape Cod Canal," the report stated.

see **Canal Bridges** on Page 2

According to the Corps, the study "has determined that providing two new highway bridges would be the most cost-effective means of providing safe and reliable crossings. The existing bridges are 85 years old and are functionally obsolete."

The Corps owns the bridges, which it built between 1933 and 1935.

Colonel William Conde, commander of the US Army Corps of Engineers for the New England District, said the draft report recommends new structures that will include four travel lanes and two acceleration/deceleration lanes "built to modern highway standards."

The bridges would also be built "with appropriate bike/pedestrian access," the colonel said.

The Corps has scheduled five public meetings this month on the draft report recommendations.

The first will be held next Wednesday, October 16, at 6 PM in the auditorium at Bourne High School. The Corps invites the public to attend and provide input on the draft report.

Replacing the bridges, instead of continuing to repair them, also was the recommendation of MassDOT's Cape Cod Canal Region Transportation Study Group.

The study group issued the results of its five-year study in February.

The existing bridges were constructed 85 years ago. They were built to replace two earlier bridges that had proven to be problematic.

The original Bourne and Sagamore bridges were drawbridges that were electrically operated, and, when opened, provided a 140-foot navigational clearance.

However, the swift current of the canal proved dangerous for vessels waiting for the drawbridges to be opened.

Fear among mariners led to an underwhelming number of vessels passing through the canal in its first few years, causing it to be deemed a failure.

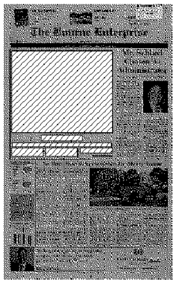
During World War I, President Woodrow Wilson ordered the canal taken over by the Federal Railroad Administration. After the war, it was returned to the control of original owner August Belmont, but it became apparent that improvements needed to be made to the canal bridges.

In 1928, under authority of the federal Rivers and Harbors Act of 1927, the Army Corps took over operation of the Cape Cod Canal. The Army Corps widened and deepened the canal, and constructed three new bridges: the Bourne and Sagamore vehicular bridges, and the Buzzards Bay railroad bridge.

A Boston Sunday Globe article reported that 1,200 men worked on building the bridges, and roughly 2,000 men worked in the Pennsylvania steel mills, making the pieces used in construction.

Workers were both skilled and unskilled. Skilled laborers earned $1.50 an hour, while unskilled workers made 50 cents an hour.

One of the more significant additions to the bridges was the installation of railing to cut down on the suicides and suicide attempts. In 1977 alone, nine people took their lives jumping from the two bridges. Repeated suggestions to make the bridges safer were made by the Samaritans of Cape Cod, a



© 2019 BOURNE ENTERPRISE
All Rights Reserved.

non-denominational, nonprofit volunteer organization that provides emotional support to the lonely, depressed, or suicidal.

In 1981 the Army Corps agreed to install the eight-feet-high railings now in place on the bridges.

In recent years, the Bourne and Sagamore bridges have required increasingly more frequent repair and maintenance, which is costly and causes significant slowdowns for traffic crossing the Cape Cod Canal.

In spring last year the Sagamore Bridge underwent extensive repairs that required lane closures and caused traffic gridlock. News of the work to be done drew a harsh rebuke from Cape Cod Chamber of Commerce CEO Wendy K. Northcross, as well as other chamber members and members of the Cape business community.

That community criticized the Army Corps for scheduling the bridge work during the Cape's shoulder season when businesses are gearing up for the busy summer months. Similar outrage was expressed when repairs and commuter snarls were the result of work done on the Bourne Bridge this past spring.

Ms. Northcross and other chamber members have established Coalition for the Fix, an advocacy group lobbying in favor of having the two canal bridges replaced in order to avoid the periodic repairs they say jeopardizes business on the Cape.

Wider bridges will allow for a freer flow of traffic and make it easier for people who live and work on the Cape to get their children to school, or aging parents to a doctor appointment, she said.

"The whole point of the project is to create a more reliable transportation system for Cape residents primarily, but also for visitors," Ms. Northcross said.

Judith M. Froman, chairman of the Bourne Board of Selectmen, suggested that wider lanes might increase the speed at which people travel over the bridges. That, in turn, could be helpful in keeping traffic flowing over the bridges, Ms. Froman said.

Wider bridges, she said, could also mean more room for drivers to react to an unexpected event.

"It is amazing to me how often people slow down to look at the view and they cause accidents," Ms. Froman said. "Maybe we need a viewing tower like at the Penobscot Stonington bridge in Maine."

The Corps said it will accept public comments on the recommendations in the study through Friday, November 1. In addition to next Wednesday's meeting at Bourne High, other Cape meetings will be held: on Thursday, October 17, at Plymouth South High School Performing Arts Center; Tuesday, October 22, at Nauset Regional High School in Eastham; and Wednesday, October 23, at the Barnstable High School Performing Arts Center in Hyannis. Those meetings also begin at 6 PM.

The fifth meeting is scheduled for Monday, October 21, at 1 PM, at the Thomas P. O'Neill Jr. Federal Building on Causeway Street in Boston.

At the end of the public comment period, the Corps will address issues raised by the public. In addition to public comment, the draft report will also undergo an independent external peer review by members of the private and academic sectors, the Corps said.

A final recommendation on whether to replace or continue to repair the Cape Cod Canal bridges will be contained in the final report that will be submitted to Corps headquarters in Washington, DC, in February 2020.

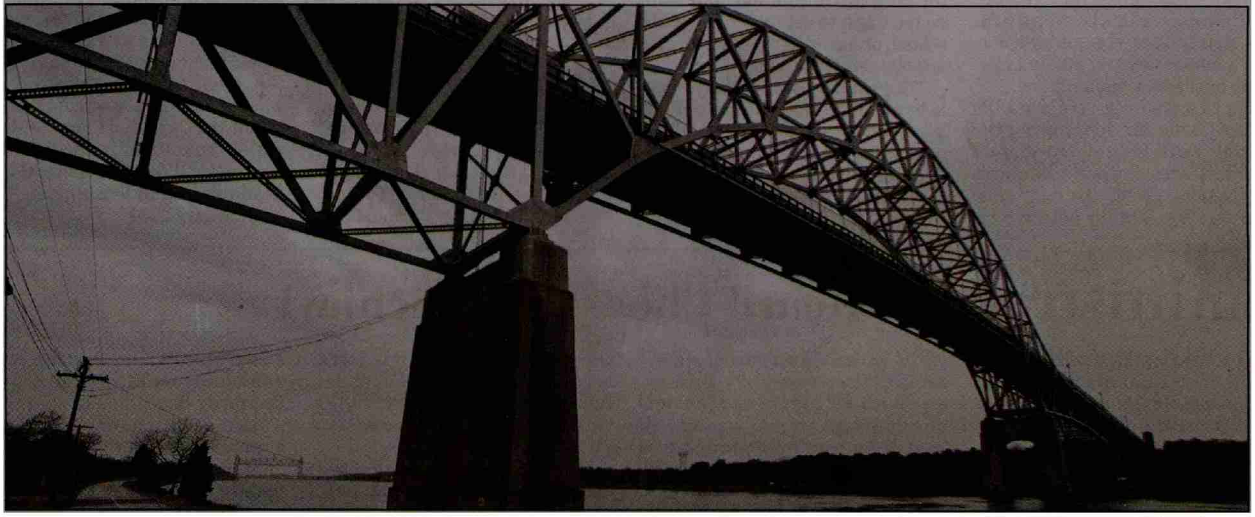
© 2019 BOURNE ENTERPRISE
All Rights Reserved.

For reprints or rights, please contact the publisher

BOURNE ENTERPRISE

Date: Friday, October 11, 2019
Location: FALMOUTH, MA
Circulation (DMA): 8,738 (9)
Type (Frequency): Newspaper (W)
Page: 1,2
Section: Main
Keyword: U.S. Army Corps of Engineers

PHOTOGRAPHS BY GENE M. MARCHAND/ENTERPRISE



PHOTOGRAPHS BY BRENDA M. SHARP/ENTERPRISE

The Bourne Bridge and the Sagamore Bridge were built in a program under President Franklin Roosevelt's New Deal.

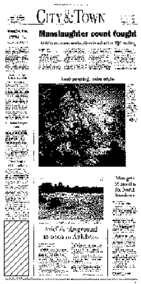
© 2019 BOURNE ENTERPRISE
All Rights Reserved.

THE SUN CHRONICLE

Date: Tuesday, October 22, 2019
Location: ATTLEBORO, MA
Circulation (DMA): 9,321 (56)
Type (Frequency): Newspaper (D)
Page: A3
Section: Main
Keyword: U.S. Army Corps of Engineers

Cape bridge input sought

Feedback is wanted on plans to replace the two **Cape Cod Canal bridges**, the Bourne and Sagamore bridges. The **U.S. Army Corps of Engineers** recently recommended the replacement of the 85-year-old spans instead of rehabbing them. A hearing on the plans is being held Wednesday, Oct. 23 at Barnstable High School Performing Arts Center at 744 West Main St. in Hyannis. Registration and open house starts at 6 p.m., with the meeting at 6:30. The Corps is accepting comments through Nov. 1 at www.CapeCodCanalBridges-Study.com or by mail at U.S. Army Corps of Engineers, New England District, Attn. Craig Martin, 696 Virginia Road, Concord, MA 01742-2751. Comments can also be emailed to nae-pn-nav@usace.army.mil



© 2019 SUN CHRONICLE
All Rights Reserved.

For reprints or rights, please contact the publisher

CAPE COD TIMES
capecodONLINE.com The Cape and Islands' Daily Newspaper

Date: Wednesday, October 30, 2019
Location: HYANNIS, MA
Circulation (DMA): 19,153 (9)
Type (Frequency): Newspaper (D)
Page: 1,4
Section: Main
Keyword: U.S. Army Corps of Engineers

State official: Takeover of canal bridges 'on table'

Transfer from Army Corps would not occur until after aging spans are replaced

By Ethan Genter
egenter@capecodonline.com

BOSTON — A transfer of the Bourne and Sagamore bridges from the U.S. Army Corps of Engineers to the state after they are replaced is "on the table," according to the state's highest transportation official.

Having the bridges in the hands of the state, which owns the roads that lead to the spans, would give the state more control, Massachusetts Department of Transportation Secretary Stephanie Pollack said at a board meeting Monday.

"We've not volunteered to take the bridges in their current condition. This would not be an as-is transfer," she said. "The issue has been raised: Would we consider doing it after they were newly constructed, and it would certainly give us more control over that next 50 years if we had new bridges — over inspections, maintenance and keeping them in good shape."

See BRIDGES, A4

But she emphasized the idea is only in the preliminary stages.

"It's on the table but no final conclusion has been reached, nor would it be reached until we had a (memorandum of understanding) ready," she said.

The Corps, which manages and operates the two automobile crossings over the Cape Cod Canal, is currently taking public comment on a draft plan that recommends replacing the existing bridges with wider bridges that have two added auxiliary lanes, a median, shoulders and a pedestrian and bike path.

The bridges are 84 years old, and replacement is estimated at $1 billion.

The Corps is not normally in the business of maintaining traffic bridges, and the idea was talked about because the bridges are critical links in the state road network, Corps officials have said.

The state and the Corps have a memorandum of understanding that lays out how they will proceed in the bridge replacement process, but a second memo is in the works, Pollack said.

"We have started conversations on a second, more detailed memorandum of understanding that we would not execute until after the Army Corps finishes its formal process," she said.

The possibility of the state taking over the bridges after they are replaced could help leverage more money from the federal government and end up working for both parties, said U.S. Rep. William Keating, D-Mass.

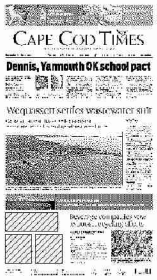
"I think it's a complementary move," he said.

The idea has been discussed in several meetings between the Corps and the state and no objections have been raised, said Keating, who lives in Bourne, not far from the bridges.

"People have said. 'You know this makes a great deal of sense,'" he said.

Cape legislators, however, had mixed feelings on the potential transfer.

"I think it's a wonderful idea,"



© 2019 Dow Jones Local Media Group, Inc.
All Rights Reserved.

For reprints or reuse, please e-mail sean.polay@dowjones.com or
send a letter to Sean Polay, Dow Jones Local Media Group, Box 580, Middletown, NY 10940

state Rep. William Crocker, R-Centerville, said.

Having the bridges and the roads leading to them all under the same ownership umbrella would make it easier to have local voices heard, he said.

Any chance of changing hands is still a long way off.

"It's still very, very much in the planning stages at this point," Crocker said.

State Rep. David Vieira, R-Falmouth, was open to talking about the idea but had reservations when it came to future funding and tolls.

"Clearly the federal government has the obligation to replace the bridges," he said. "Any future discussion of ownership, I'd be open to discussing."

The Corps is obligated to keep the crossings toll-free; the state, however, is not. Vieira worried that, at some point to keep up with the costs of maintaining the bridges, the state could turn to tolls.

"That's a concern I have," he said.

Follow Ethan Genter on Twitter: @EthanGenterCCT.

Online

Read more coverage of Cape Cod bridges: **capecodtimes.com**

Pollack

Crocker

Vieira

© 2019 Dow Jones Local Media Group, Inc.
All Rights Reserved.

For reprints or reuse, please e-mail sean.polay@dowjones.com or
send a letter to Sean Polay, Dow Jones Local Media Group, Box 580, Middletown, NY 10940

CAPE COD TIMES
capecodONLINE.com The Cape and Islands' Daily Newspaper

Date: Thursday, October 24, 2019
Location: HYANNIS, MA
Circulation (DMA): 19,153 (9)
Type (Frequency): Newspaper (D)
Page: 2
Section: Main
Keyword: U.S. Army Corps of Engineers

Army Corps leader commits to bridge project

Replacement of canal spans may require 'out-of-the-box' solution, official says

By Ethan Genter
egenter@capecodonline.com

WASHINGTON — The highest-ranking official in the U.S. Army Corps of Engineers said Wednesday that he is committed to replacing the Bourne and Sagamore bridges, but it may take some innovative ideas to get it done.

Lt. Gen. Todd Semonite told Sen. Edward Markey, D-Mass., at a Senate Environment and Public Works Committee hearing that the Corps planned to put the project on its work plan, a list of projects that go beyond the normal line items in its civil works budget.

"You have our commitment in the work plan and just from an engineering perspective to fight to get these done," Semonite said.

Last week, Markey and fellow Democrats Sen. Elizabeth Warren and U.S. Rep. William Keating wrote a letter to Semonite asking him to allocate the necessary funding to replace the bridges.

The Corps is taking public comment through Nov. 1 on a draft report that recommends replacing the bridges.

"These two bridges are vitally important," Markey said. "They connect the nearly 250,000 residents of the Cape with the rest of Massachusetts, and the tourism community is obviously very important."

The Corps' budget historically has been about $5 billion a year, so projects as big as the bridge replacement, which is estimated at $1 billion, can be difficult to fund, said Scott Acone, the Corps' deputy district engineer for programs and project management in New England.

"That's about 20% of our budget," he said.

If Congress appropriates more money for different programs, the Corps uses the work plan as a guide for what to fund.

The bridges are the No. 1 priority for the Corps' New England district, Acone said, but the money Congress puts toward the work plan can vary widely from year to year.

Projects such as the bridges may need creative long-term solutions to get done, Semonite said.

"I have been to those bridges three times personally. I've talked to the governor personally about this. We need to look at an out-of-the-box solution here," he said.

The Corps has looked at something similar to a reverse mortgage to pay for projects that are not only expensive but also a critical pinch point in the transportation infrastructure, he said.

"I would encourage, not only for this particular project but for other projects that this committee has that are so important to this nation and there is a single point of failure, that we've got to find another way to get these projects approved," Semonite said.

Follow Ethan Genter on Twitter: @EthanGenterCCT.

© 2019 Dow Jones Local Media Group, Inc.
All Rights Reserved.

Account: 31366 (20202)
MA-117

For reprints or reuse, please e-mail sean.polay@dowjones.com or
send a letter to Sean Polay, Dow Jones Local Media Group, Box 580, Middletown, NY 10940

The Enterprise

Date: Friday, October 25, 2019
Location: BROCKTON, MA
Circulation (DMA): 6,500 (9)
Type (Frequency): Newspaper (D)
Page: 1
Section: Main
Keyword: U.S. Army Corps of Engineers

STATE

ARMY CORPS COMMITS TO REPLACING CAPE COD BRIDGES

The highest-ranking official in the U.S. Army Corps of Engineers said Wednesday he is committed to replacing the Bourne and Sagamore bridges, but it may take some innovative ideas to get it done. The Corps' budget historically has been about $5 billion a year, so projects as big as the bridge replacement, which is estimated at $1 billion, can be difficult to fund.

PAGE 3

The Enterprise

The gloves come off in final Brockton mayoral debate

© 2019 ENTERPRISE
All Rights Reserved.

For reprints or rights, please contact the publisher

SANDWICH ENTERPRISE

Date: Friday, October 25, 2019
Location: FALMOUTH, MA
Circulation (DMA): 3,509 (9)
Type (Frequency): Newspaper (W)
Page: 4
Section: Main
Keyword: U.S. Army Corps of Engineers

When It Comes To The Bridges, Really Consider All Alternatives

The Army Corps of Engineers apparently considered alternatives to replacing the bridges over the canal with wider spans. Among them were a third bridge between the current bridges, a tunnel running beneath the canal, filling in the canal and a series of low bridges connecting the Cape to the mainland.

To what extent the Army Corps considered those options is a question that project manager Craig Martin did not answer at a meeting last week at Bourne High School. We don't expect anyone gave a lot of thought to filling in the canal or building a tunnel; it's pretty obvious that those options make no sense.

But replacing the existing spans with low bridges might. Would it not cost less, maybe even much less? Bridges built shore to shore without approaches would be shorter. The bridges could be made even shorter by filling in either side of the canal and, in effect, creating a causeway.

Once constructed, wouldn't shorter and lower bridges be less costly to maintain?

Such a plan, especially a causeway concept, would put an end to certain types of canal traffic. Barges would no longer be able to get through, nor would cruise ships, commercial fishing boats, sailboats and large sport fishing vessels and cruisers.

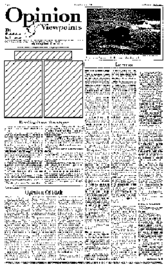
That is a problem. But whose problem is it?

It is estimated that replacing the bridges will cost $1 billion. What if half that could be saved by causeway-type construction? That $500 million is a lot of money. Should taxpayers be asked to subsidize barge companies, commercial fishermen and cruise lines? Should taxpayers be asked to pay for the convenience and enjoyment of sailors and sport fishermen?

If the Army Corps moves ahead with its current replacement scheme, maybe the users of the canal should pay with the equivalent of tolls. Has that idea ever been considered?

And what is the trend in the use of the canal? The canal is no longer the commercial necessity it once was. Global Positioning Systems and other navigational advances have made circumnavigating the Cape safe; the shoals that were once a menace to shipping are today easy to avoid. How might use of the canal change in the future?

If the Army Corps of Engineers has not considered all angles of alternatives to replacing the bridges, it should. Taxpayers should demand it. At $1 billion, no one should accept the status quo.



© 2019 SANDWICH ENTERPRISE
All Rights Reserved.

For reprints or rights, please contact the publisher

The Falmouth Enterprise

Date: Friday, October 25, 2019
Location: FALMOUTH, MA
Circulation (DMA): 8,738 (9)
Type (Frequency): Newspaper (W)
Page: 4
Section: Main
Keyword: U.S. Army Corps of Engineers

Bridge Alternatives

The Army Corps of Engineers apparently considered alternatives to replacing the bridges over the canal with wider spans. Among them were a third bridge between the current bridges, a tunnel running beneath the canal, filling in the canal and a series of low bridges connecting the Cape to the mainland.

To what extent the Army Corps considered those options is a question that project manager Craig Martin did not answer at a meeting last week at Bourne High School. We don't expect anyone gave a lot of thought to filling in the canal or building a tunnel; it's pretty obvious that those options make no sense.

But replacing the existing spans with low bridges might. Would it not cost less, maybe even much less? Bridges built shore to shore without approaches would be shorter. The bridges could be made even shorter by filling in either side of the canal and, in effect, creating a causeway.

Once constructed, wouldn't shorter and lower bridges be less costly to maintain?

Such a plan, especially a causeway concept, would put an end to certain types of canal traffic. Barges would no longer be able to get through, nor would cruise ships, commercial fishing boats, sailboats and large sport fishing vessels and cruisers.

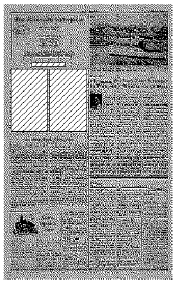
That is a problem. But whose problem is it?

It is estimated that replacing the bridges will cost $1 billion. What if half that could be saved by causeway-type construction? That $500 million is a lot of money. Should taxpayers be asked to subsidize barge companies, commercial fishermen and cruise lines? Should taxpayers be asked to pay for the convenience and enjoyment of sailors and sport fishermen?

If the Army Corps moves ahead with its current replacement scheme, maybe the users of the canal should pay with the equivalent of tolls. Has that idea ever been considered?

And what is the trend in the use of the canal? The canal is no longer the commercial necessity it once was. Global Positioning Systems and other navigational advances have made circumnavigating the Cape safe; the shoals that were once a menace to shipping are today easy to avoid. How might use of the canal change in the future?

If the Army Corps of Engineers has not considered all angles of alternatives to replacing the bridges, it should. Taxpayers should demand it. At $1 billion, no one should accept the status quo.



© 2019 FALMOUTH ENTERPRISE
All Rights Reserved.

For reprints or rights, please contact the publisher

Daily Times Chronicle
Date: Tuesday, November 05, 2019
Location: WOBURN, MA
Circulation (DMA): 2,585 (9)
Type (Frequency): Newspaper (D)
Page: B8
Section: Sports
Keyword: U.S. Army Corps of Engineers

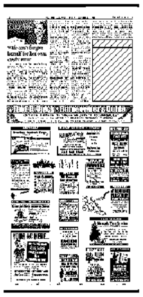
Cape Cod Canal bridges seek public input on upgrades

CONCORD - The U.S. Army Corps of Engineers, New England District, has extended the public comment period through Friday, November 15 for public input to the recommendation in the Cape Cod Canal Highway Bridges Major Rehabilitation Evaluation Study on the future of the highway bridges spanning the Cape Cod Canal in Bourne.

The Corps recommendation, documented in the draft Major Rehab Evaluation Report, is to replace the Bourne ad Sagamore highway bridges with new structures to include the 4 authorized travel lanes and 2 additional auxiliary lanes, designed as acceleration/deceleration lanes built to modern highway standards with appropriate bike/pedestrian access.The Draft Major Rehabilitation Evaluation Report (MRER) and Draft Environmental Assessment are available for review on the website at https://www.CapeCodCanalBridgeStudy.com under the "Documents" tab. The Corps will accept public comments on the recommendation contained within the draft bridge study through November 15, 2019.

The two bridges are major go-through bridges for motorists from the Greater Boston area, as well as New England, the East Coast, Canada and elsewhere. Much interest and concern has been expressed over the efficiency of the two bridges for decades.

The Corps will accept public comments on the draft study through November 15. Public comments can be e-mailed (see above) or mailed to U.S. Army Corps of Engineers, New England District (Attn: Craig Martin), 696 Virginia Rd., Concord, MA 01742-2751, or also to nae-pn-nav@usace.army.mil.



© 2019 DAILY TIMES CHRONICLE (READING EDITION)
All Rights Reserved.

For reprints or rights, please contact the publisher

OLD COLONY MEMORIAL

Date: Saturday, November 02, 2019
Location: PLYMOUTH, MA
Circulation (DMA): 4,453 (9)
Type (Frequency): Newspaper (2WK)
Page: A3
Section: Main
Keyword: U.S. Army Corps of Engineers

Still time to speak on Canal bridges

Deadline extended for comment on Cape Cod Canal bridges project

By David Kindy
dkindy@wickedlocal.com

Have something to say about the planned construction of two new highway bridges over the Cape Cod Canal? You can still do so until Nov. 15.

The New England District of the Army Corps of Engineers has extended the deadline for public comment. Residents can make their thoughts known online, by email or via regular mail.

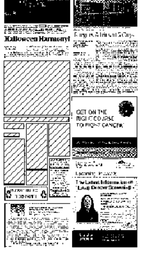
The Corps of Engineers announced last month that it will recommend constructing two new spans to replace the Sagamore and Bourne bridges, which are nearly 85 years old. It issued the Cape Cod Canal Highway Bridges Major Rehabilitation Evaluation Study outlining its recommendation.

In the meantime, the Corps of Engineers began conducting public sessions to get input from people regarding their concerns about the project. One meeting was held Oct. 17 at Plymouth South High School for residents to learn about the work, which is estimated to cost more than $1 billion and could begin as soon as 2025.

The Corps of Engineers recommends replacing the two highway bridges with new structures built to include four authorized travel lanes and two additional auxiliary lanes for use as acceleration and deceleration lanes. The bridges would also include bicycle and pedestrian access.

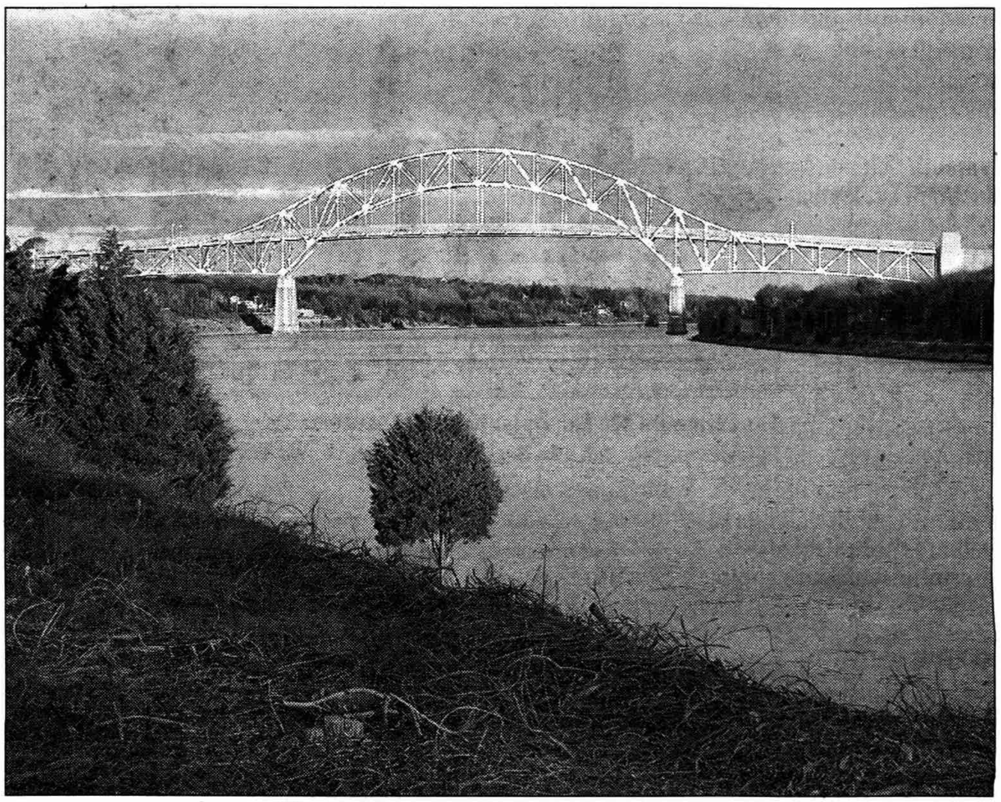
In addition to public comment, the Major Rehabilitation Evaluation Study will undergo an independent external peer review by the private and academia sectors before. The final report will be submitted to Corps of Engineers headquarters in Washington, D.C., for a decision to be announced in February.

The Army Corps of Engineers will accept public comments on the draft study through Nov. 15. They can be submitted online at www.CapeCodCanalBridgesStudy.com, emailed to nae-pn-nav@usace.army.mil or sent in writing to U.S. Army Corps of Engineers, New England District, (Attn: Craig Martin), 696 Virginia Road, Concord, MA 01742-2751.



© 2019 OLD COLONY MEMORIAL
All Rights Reserved.

For reprints or rights, please contact the publisher



Sagamore Bridge, which spans the Cape Cod Canal, at sunset

© 2019 OLD COLONY MEMORIAL
All Rights Reserved.

METRO WEST DAILY NEWS

Date: Saturday, October 05, 2019
Location: FRAMINGHAM, MA
Circulation (DMA): 6,982 (7)
Type (Frequency): Newspaper (D)
Page: 1,4
Section: Main
Keyword: U.S. Army Corps of Engineers

Army Corps: Replace the canal bridges

Long-awaited study concludes replacement of aging spans more cost-effective than rehabilitation

By Ethan Genter
egenter@capecodonline.com

CONCORD — In a report released Thursday night, the Army Corps of Engineers recommended replacing the aging Bourne and Sagamore bridges, with construction possibly starting in 2025. The recommendation came in a draft version of the Corps' long-awaited Major Rehabilitation Evaluation Study, which weighed rehabbing the two 84-year-old bridges against replacing them.

The Corps, which owns and maintains the bridges, determined that the estimated $1.5 billion to replace them would be more cost-effective than the similar amount it would take to rehabilitate them.

As recommended, each new bridge would have four travel lanes, two in each direction, and an auxiliary lane on both sides. There also are plans for a median, shoulders and a separate bike and pedestrian lane, which the current bridges do not have. The lanes also would be widened from 10 to 12 feet.

The existing bridges would remain open during construction and be demolished after the new bridges are finished. The new Sagamore Bridge would be built to the west of the existing bridge and the new Bourne Bridge to the east of that span.

See BRIDGES, A4

Replacing the bridges would have minimal disturbances to traffic during construction, according to the report. But the existing bridges would still need maintenance during that time.

The Corps estimated that it would need to acquire 11 acres for the new Bourne Bridge and about 4.5 acres for the Sagamore Bridge. The cost of acquisition, improvements and relocation of businesses was estimated at $7.8 million per bridge.

The Cape Cod Canal was built in 1916 to cut down on travel times for ships heading south from Boston. The bridges were built about 20 years later, at a time when the Cape's population was about 26,000 people and vehicles were much smaller than the SUVs and trucks that cross the bridges every day now.

Both bridges are structurally deficient and do not meet modern-day standards.

"The existing bridges were constructed 84 years ago and require increasingly more frequent repair and maintenance, which is costly and causes significant impact to traffic crossing the Cape Cod Canal," the Army Corps wrote in a statement.

With the release of the draft report, the Corps is kicking off a public comment period to start later this month. Public meetings will be held in Bourne, Plymouth, Boston, Eastham and Hyannis.

The Corps will review those comments and then finalize its report and give its decision, possibly by spring. That timeline could provide for construction to start in 2025.

The final report will be submitted to Corps headquarters in Washington, D.C,. for a decision in February. Public comments on the report will be taken through Nov. 1.

"I am pleased to see that the Army Corps. of Engineers' report concludes that the best and most cost-effective way to manage the vital transportation link over the Cape Cod Canal is to construct two modern bridges to replace the Bourne and the Sagamore," U.S. Rep. William Keating, D-Mass, said in a statement. "Two new bridges built up to modern standards will improve traffic flow, allow better access to the Cape and Islands in the coming years, and provide vital evacuation routes ... As a year-round resident of Cape Cod who depends on the Bourne Bridge, I strongly feel that this is the best outcome for our Cape and Islands community and the greater Southeastern region as a whole. Our federal delegation stands together in pursuing funding in Congress for this important project."

The Massachusetts Department of Transportation came to a similar conclusion about the bridges in May. After a five-year study, the state proposed bridges that were 138 feet wide — 90 feet wider than the existing ones. The department envisioned each bridge with six 12-foot lanes, a 10-foot-wide median, a 12-foot-wide shared-use path and a 6-foot sidewalk on either side.

The state also recommended revamping several of the roads leading to the bridges; bonds for that work were proposed in Gov. Charlie Baker's $18 billion bond bill earlier this year.

A hearing on that bill is scheduled for Oct. 8, Cape Cod Regional Transit Authority Administrator Thomas Cahir said.

© 2019 METRO WEST DAILY NEWS
All Rights Reserved.

For reprints or rights, please contact the publisher

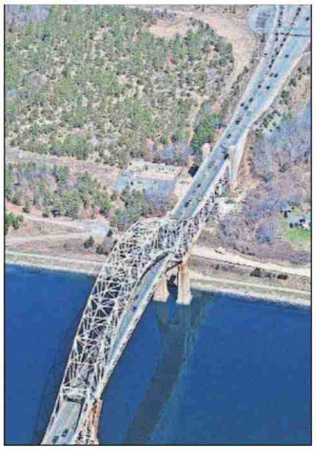
Multiple bills before Congress could help pay for the bridges, including a $5 million amendment in an appropriations bill that would pay for their design and a $1 billion bill that would bolster the nation's evacuation routes, of which the bridges are a component.

Rehabilitation of the bridges was estimated to take 3½ years and result in temporary and full closures.

Other scenarios looked at in the Corps report include replacing replacing both bridges with a single bridge; the addition of a third automobile bridge not overseen by the Corps; replacement of the bridges with tunnels; and even filling in the canal.

Follow Ethan Genter on Twitter: @EthanGenterCCT.

Traffic backs up on the Bourne Bridge heading into the rotary during one of the increasingly frequent maintenance and construction projects. [STEVE HEASLIP/CAPE COD TIMES]



An aerial view of the Sagamore Bridge as traffic backs up heading on to the Cape. The Army Corps of Engineers, which owns and maintains both vehicular bridges over the canal, has recommended replacing them. [STEVE HEASLIP/CAPE COD TIMES]

© 2019 METRO WEST DAILY NEWS
All Rights Reserved.

MILFORD DAILY NEWS
Date: Saturday, October 05, 2019
Location: MILFORD, MA
Circulation (DMA): 6,904 (7)
Type (Frequency): Newspaper (D)
Page: 1,7
Section: Main
Keyword: U.S. Army Corps of Engineers

Army Corps: Replace the canal bridges

Long-awaited study concludes replacement of aging spans more cost-effective than rehabilitation

By Ethan Genter
egenter@capecodonline.com

CONCORD — In a report released Thursday night, the Army Corps of Engineers recommended replacing the aging Bourne and Sagamore bridges, with construction possibly starting in 2025. The recommendation came in a draft version of the Corps' long-awaited Major Rehabilitation Evaluation Study, which weighed rehabbing the two 84-year-old bridges against replacing them.

The Corps, which owns and maintains the bridges, determined that the estimated $1.5 billion to replace them would be more cost-effective than the similar amount it would take to rehabilitate them.

See BRIDGES, A7

As recommended, each new bridge would have four travel lanes, two in each direction, and an auxiliary lane on both sides. There also are plans for a median, shoulders and a separate bike and pedestrian lane, which the current bridges do not have. The lanes also would be widened from 10 to 12 feet.

The existing bridges would remain open during construction and be demolished after the new bridges are finished. The new Sagamore Bridge would be built to the west of the existing bridge and the new Bourne Bridge to the east of that span.

Replacing the bridges would have minimal disturbances to traffic during construction, according to the report. But the existing bridges would still need maintenance during that time.

The Corps estimated that it would need to acquire 11 acres for the new Bourne Bridge and about 4.5 acres for the Sagamore Bridge. The cost of acquisition, improvements and relocation of businesses was estimated at $7.8 million per bridge.

The Cape Cod Canal was built in 1916 to cut down on travel times for ships heading south from Boston. The bridges were built about 20 years later, at a time when the Cape's population was about 26,000 people and vehicles were much smaller than the SUVs and trucks that cross the bridges every day now.

Both bridges are structurally deficient and do not meet modern-day standards.

"The existing bridges were constructed 84 years ago and require increasingly more frequent repair and maintenance, which is costly and causes significant impact to traffic crossing the Cape Cod Canal," the Army Corps wrote in a statement.

With the release of the draft report, the Corps is kicking off a public comment period to start later this month. Public meetings will be held in Bourne, Plymouth, Boston, Eastham and Hyannis.

The Corps will review those comments and then finalize its report and give its decision, possibly by spring. That timeline could provide for construction to start in 2025.

The final report will be submitted to Corps headquarters in Washington, D.C,. for a decision in February. Public comments on the report will be taken through Nov. 1.

"I am pleased to see that the Army Corps. of Engineers' report concludes that the best and most cost-effective way to manage the vital transportation link over the Cape Cod Canal is to construct two modern bridges to replace the Bourne and the Sagamore," U.S. Rep. William Keating, D-Mass, said in a statement. "Two new bridges built up to modern standards will improve traffic flow, allow better access to the Cape and Islands in the coming years, and provide vital evacuation routes ... As a year-round resident of Cape Cod who depends on the Bourne Bridge, I strongly feel that this is the best outcome for our Cape and Islands community and the greater Southeastern region as a whole. Our federal delegation stands together in pursuing funding in Congress for this important project."

The Massachusetts Department of Transportation came to a similar conclusion about the bridges in May. After a

© 2019 MILFORD DAILY NEWS
All Rights Reserved.

five-year study, the state proposed bridges that were 138 feet wide — 90 feet wider than the existing ones. The department envisioned each bridge with six 12-foot lanes, a 10-foot-wide median, a 12-foot-wide shared-use path and a 6-foot sidewalk on either side.

The state also recommended revamping several of the roads leading to the bridges; bonds for that work were proposed in Gov. Charlie Baker's $18 billion bond bill earlier this year.

A hearing on that bill is scheduled for Oct. 8, Cape Cod Regional Transit Authority Administrator Thomas Cahir said.

Multiple bills before Congress could help pay for the bridges, including a $5 million amendment in an appropriations bill that would pay for their design and a $1 billion bill that would bolster the nation's evacuation routes, of which the bridges are a component.

Rehabilitation of the bridges was estimated to take 3½ years and result in temporary and full closures.

Other scenarios looked at in the Corps report include replacing replacing both bridges with a single bridge; the addition of a third automobile bridge not overseen by the Corps; replacement of the bridges with tunnels; and even filling in the canal.

Follow Ethan Genter on Twitter: @EthanGenterCCT.

Karen Mendez with her inflatable Halloween dragon on her front lawn in Framingham. If Framingham does cancel trick-or-treating on Halloween night because of the risk of EEE, then Mendez said she and her kids will go to Natick Mall and have fun. [DAILY NEWS STAFF PHOTO/HENRY SCHWAN]

© 2019 MILFORD DAILY NEWS
All Rights Reserved.

OLD COLONY MEMORIAL

Date: Wednesday, October 09, 2019
Location: PLYMOUTH, MA
Circulation (DMA): 4,453 (7)
Type (Frequency): Newspaper (2WK)
Page: A9
Section: Main
Keyword: U.S. Army Corps of Engineers

Friendly political rivals share successes

Area legislators talk about efforts to help Plymouth and beyond

By David Kindy
dkindy@wickedlocal.com

What do you get when you take a bunch of politicians from both parties and throw them in a room together? Mutual respect and good-natured kidding.

That was the case at the 2019 Legislative Breakfast, presented Friday by the Plymouth Area Chamber of Commerce at the Hotel 1620 Plymouth Harbor. Instead of rancorous debate and name-calling, local politicians joked with each other and related how they work together to solve problems at the State House and in the district.

"Even though we come from different backgrounds, we're all friends," said state Sen. Vinny deMacedo. "We don't take it personally. We maintain decorum and agree to disagree."

The spirit of congeniality was evident throughout the Legislative Breakfast as each speaker – Democrat or Republican – supported their colleagues on a myriad of issues concerning local communities: economic development, gambling, transportation, tourism and more.

DeMacedo, R-Plymouth, led off the session by discussing how the Massachusetts Legislature has been working to increase funding for the Rainy Day Fund. The stabilization account has grown substantially in less than five years, from $1.8 billion in 2015 to $2.6 billion today. It is expected to reach $3.5 billion by 2020. The fund helps the state pay for important programs when tax revenues fall during economic decline, and a strong fund helps make for a strong financial rating.

"We have to be prepared," he said. "When things get bad, that's when you need the Rainy Day Fund. We're in a much better position now than we've ever been."

The racetrack and gambling proposal announced for Wareham was discussed by state Rep. Susan Williams Gifford, R-Wareham. She has filed legislation to have the Massachusetts Gaming Commission review the plans and determine its viability for Region C, which includes Southeastern Massachusetts.

"We want to know if the state can support another casino," she said. "Having this proposal reviewed by the commission will help us understand what we can sustain. This is the first step."

The impact of replacing the Sagamore and Bourne bridges over the Cape Cod Canal was discussed by state Rep. Randy Hunt, R-Sandwich. On Thursday, the U.S. Army Corps of Engineers announced new bridges were necessary and it hoped to begin construction as early as 2025. He detailed the planned improvements, which include wider and additional lanes.

"These changes will help a lot," he said. "Traffic will move much more quickly, which will provide a lot of relief." He added, "Ten years from now, we could be using two new spans."

State Rep. Matt Muratore, R-Plymouth, talked about the "significant dollars" that have gone into infrastructure improvements to help Plymouth prepare for its 400th anniversary in 2020. He said the federal and state delegation worked together to secure $14 million for dredging Plymouth Harbor so larger cruise ships and other vessels can visit.

"The eyes of the country and the world will be on us," he said. "The focus will be on us all year and beyond 2020."

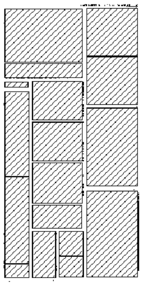
The challenge of dealing with the opioid crisis was the focus of Plymouth County District Attorney Tim Cruz' talk. Cruz, a Republican from Marshfield, described how the Plymouth County Drug Task Force has become a national model by working to reduce opioid deaths while getting referrals for addiction therapy are going up.

"Things are happening here," he said. "We've made a lot of progress, but there's still more we need to do with your help."

State Rep. Josh Cutler, D-Duxbury, discussed his role as a leader of the Workability Taskforce to study the critical issue of workforce development for persons with disabilities.

State Rep. Kathy LaNatra, D-Kingston, discussed a petition to the Office of Business Development to establish a MassMade program to identify, connect and support businesses that produce consumer goods in the commonwealth.

Register of Deeds John Buck-



© 2019 OLD COLONY MEMORIAL
All Rights Reserved.

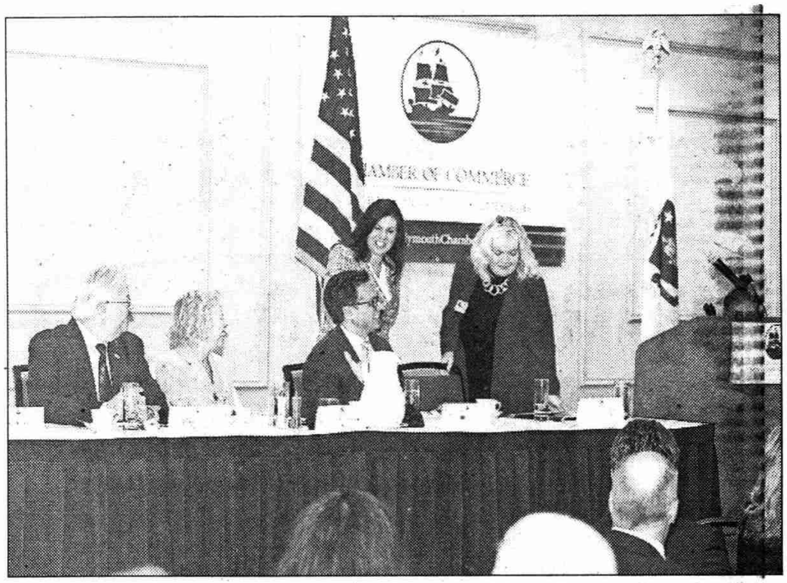
For reprints or rights, please contact the publisher

ley, D-Brockton, provided an update on the Registry's continuing efforts to enable the system to search land records back to 1686.

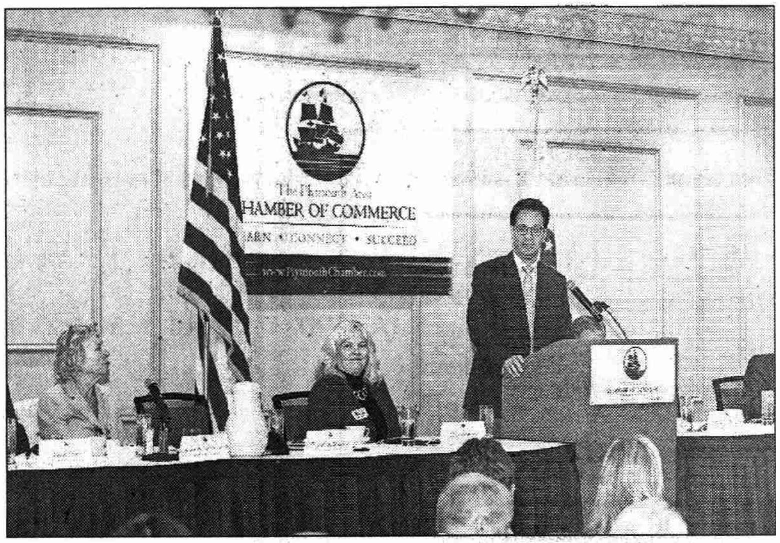
Plymouth County Sheriff John McDonald, R-Kingston informed the audience of a five-year deal with county commissioners to lease the County Farm land and continue it for agricultural and prisoner work programs.

Sharon Brown, PACC Government Affairs Committee chair, welcomes the crowd and state and local legislators to the Plymouth Area Chamber of Commerce annual Legislative Breakfast held last Friday at Hotel 1620. [WICKED LOCAL PHOTO/DENISE MACCAFERRI]

© 2019 OLD COLONY MEMORIAL
All Rights Reserved.



State Rep. Kathy LaNatra jokes with state Sen. Vinny deMacedo on her way to the podium where, she spoke about her, along with state Rep. Josh Cutler and others' petition that the Office of Business Development establish a MassMade program to identify, connect and support businesses that produce consumer goods in the commonwealth. [WICKED LOCAL PHOTO/DENISE



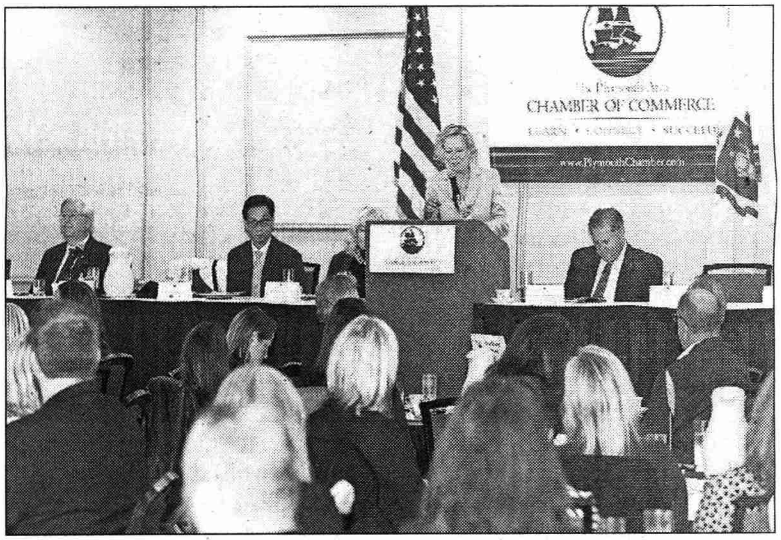
State Sen. Vinny deMacedo presents the state's healthy fiscal position.
[WICKED LOCAL PHOTO/DENISE MACCAFERRI]

© 2019 OLD COLONY MEMORIAL
All Rights Reserved.

For reprints or rights, please contact the publisher

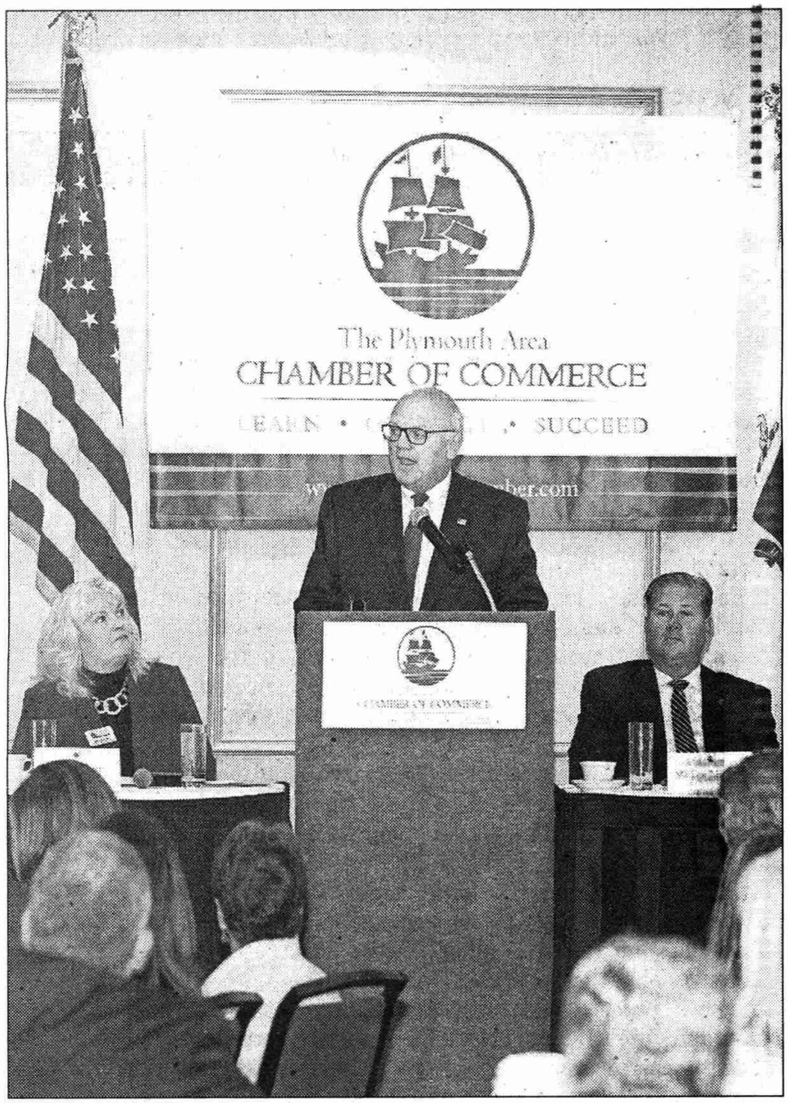
MACCAFERRI]

State Rep. Josh Cutler talked about his role as leader of the Workability Taskforce to study the critical issue of workforce development for persons with disabilities. [WICKED LOCAL PHOTO/DENISE MACCAFERRI]



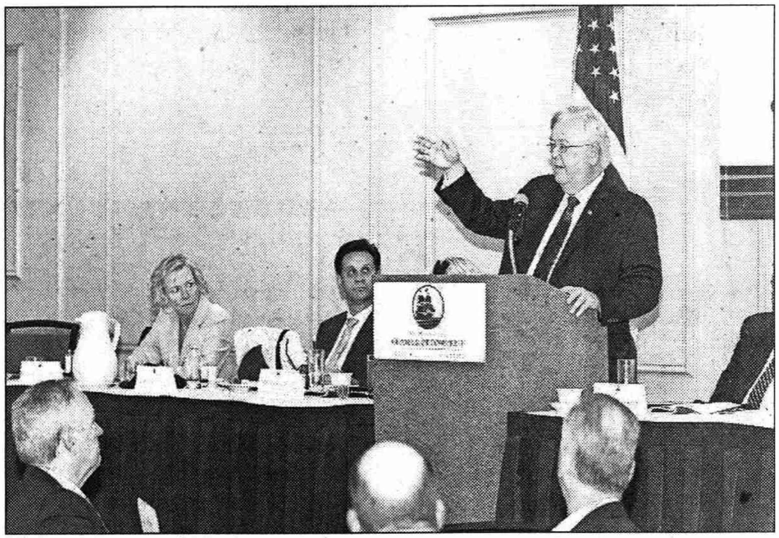
State Rep. Susan Williams Gifford spoke about a proposal for a thoroughbred race track and gambling in Wareham. [WICKED LOCAL PHOTO/DENISE MACCAFERRI]

© 2019 OLD COLONY MEMORIAL
All Rights Reserved.

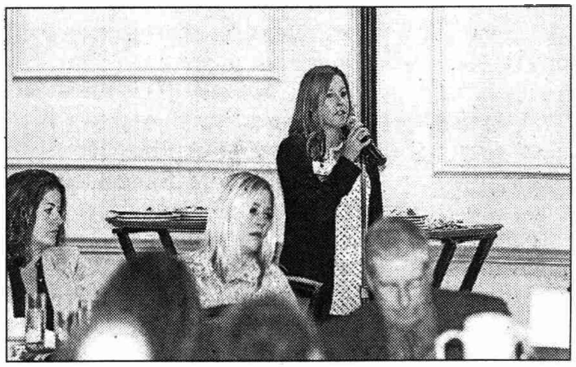


Plymouth County DA Timothy Cruz reported that Plymouth County's Drug Abuse Task Force's Outreach Program has resulted in a 26 percent decrease in fatal drug overdoses. [WICKED LOCAL PHOTO/DENISE MACCAFERRI]

© 2019 OLD COLONY MEMORIAL
All Rights Reserved.



State Rep. Randy Hunt gives some details on the recent news of the Army Corps of Engineers proposal to replace the Sagamore and Bourne bridges.
[WICKED LOCAL PHOTO/DENISE MACCAFERRI]



Stacey Jordan, area manager at HomeBridge Financial, asks the legislators about the status of gender equality legislation.
[WICKED LOCAL PHOTO/DENISE MACCAFERRI]

© 2019 OLD COLONY MEMORIAL
All Rights Reserved.

Plymouth County Register of Deeds John Buckley Jr. updates the Plymouth Chamber audience on the Registry's continuing efforts to enable the system to search land records back to 1686. [WICKED LOCAL PHOTO/DENISE MACCAFERRI]

© 2019 OLD COLONY MEMORIAL
All Rights Reserved.

The Patriot Ledger

Date: Tuesday, October 08, 2019
Location: QUINCY, MA
Circulation (DMA): 12,223 (7)
Type (Frequency): Newspaper (D)
Page: 1
Section: Main
Keyword: U.S. Army Corps of Engineers

PLANS FOR NEW CAPE COD BRIDGES WIN PRAISE

The Army Corps of Engineers' draft recommendation to build new Bourne and Sagamore bridges was no surprise to most officials on the Cape, but they were heartened to see the federal agency working in concert with the state for what would be a landmark project for the region.

PAGE 3

© 2019 PATRIOT LEDGER
All Rights Reserved.

For reprints or rights, please contact the publisher

The Enterprise

Date: Wednesday, October 23, 2019
Location: BROCKTON, MA
Circulation (DMA): 6,500 (9)
Type (Frequency): Newspaper (D)
Page: 6
Section: Main
Keyword: U.S. Army Corps of Engineers

Reviewing plans for the spans

Army Corps of Engineers gets town input on replacing canal bridges

By David Kindy

PLYMOUTH – What would happen if and when two new bridges are built over the Cape Cod Canal? Plymouth residents were asking that question at a public meeting last week with the Army Corps of Engineers, which is responsible for constructing the new spans.

Approximately 25 people attended the session on Thursday to find out what they can expect from this major project estimated at more than $1 billion, which could begin as early as 2025. Eight people asked questions and made statements about the future project. One person had concerns about how his house and business would be impacted if the bridges are replaced.

Undoubtedly, it will have an impact on local neighborhoods but the full extent is not known yet. According to Tim Dugan of the New England District of the Corps of Engineers, that's because there are still a lot of variables to be decided.

"We are preparing a draft study with an initial recommendation to replace the bridges," he said. "The report has to be completed, go through technical reviews and approved at Corps headquarters in 2020 before we seek funding. All that has to happen before we even start thinking about planning and design – if approved. That is a long way off."

The Corps of Engineers announced earlier this month it was recommending replacing both the Sagamore and Bourne bridges, which were built nearly 85 years ago. Both require extensive work to maintain and have reached the point where structural integrity is becoming an issue.

The current plan calls for constructing two new bridges with four full-size travel lanes and two additional auxiliary lanes for acceleration and deceleration – all built to modern highway standards and with bicycle and pedestrian access. The work could take up to three years to complete. The current bridges would remain in use until the new spans are completed.

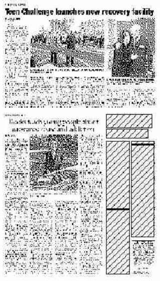
Funding for the new bridges would come from the federal government. Sens. Edward Markey and Elizabeth Warren and U.S. Rep. William Keating are urging the Corps of Engineers to include all necessary funding in its work plan for fiscal 2020.

The Sagamore and Bourne bridges, which connect nearly 250,000 residents on Cape Cod, Martha's Vineyard and Nantucket to the rest of Massachusetts, are vital to the regional and state tourism economies.

At the Plymouth meeting, the Corps of Engineers presented the draft Major Rehabilitation Evaluation Report and environmental assessment for review by the public, which can present comments for consideration. The report will also undergo an independent external peer review by the private and academia sectors before a final recommendation on whether to replace or continue to repair the Cape Cod Canal bridges is submitted to Corps headquarters in Washington, D.C., for decision in February 2020.

The Corps of Engineers will accept public comments on the draft study through Nov. 1. They can be submitted online at www.CapeCodCanalBridgesStudy.com. Written comments can be sent to: U.S. Army Corps of Engineers, New England District, (Attn: Craig Martin), 696 Virginia Road, Concord, MA 01742-2751. Comments also can be emailed to nae-pn-nav@usace.army.mil.

Reach David Kindy at dkindy@wickedlocal.com



© 2019 ENTERPRISE
All Rights Reserved.

For reprints or rights, please contact the publisher

BOURNE ENTERPRISE

Date: Friday, November 01, 2019
Location: FALMOUTH, MA
Circulation (DMA): 8,738 (9)
Type (Frequency): Newspaper (W)
Page: 4
Section: Main
Keyword: U.S. Army Corps of Engineers

When It Comes To The Bridges, Really Consider All Alternatives

The Army Corps of Engineers apparently considered alternatives to replacing the bridges over the canal with wider spans. Among them were a third bridge between the current bridges, a tunnel running beneath the canal, filling in the canal and a series of low bridges connecting the Cape to the mainland.

To what extent the Army Corps considered those options is a question that project manager Craig Martin did not answer at a meeting last week at Bourne High School. We don't expect anyone gave a lot of thought to filling in the canal or building a tunnel; it's pretty obvious that those options make no sense.

But replacing the existing spans with low bridges might. Would it not cost less, maybe even much less? Bridges built shore to shore without approaches would be shorter. The bridges could be made even shorter by filling in either side of the canal and, in effect, creating a causeway.

Once constructed, wouldn't shorter and lower bridges be less costly to maintain?

Such a plan, especially a causeway concept, would put an end to certain types of canal traffic. Barges would no longer be able to get through, nor would cruise ships, commercial fishing boats, sailboats and large sport fishing vessels and cruisers.

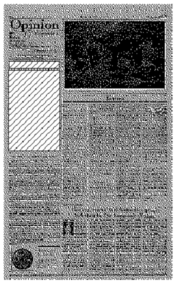
That is a problem. But whose problem is it?

It is estimated that replacing the bridges will cost $1 billion. What if half that could be saved by causeway-type construction? That $500 million is a lot of money. Should taxpayers be asked to subsidize barge companies, commercial fishermen and cruise lines? Should taxpayers be asked to pay for the convenience and enjoyment of sailors and sport fishermen?

If the Army Corps moves ahead with its current replacement scheme, maybe the users of the canal should pay with the equivalent of tolls. Has that idea ever been considered?

And what is the trend in the use of the canal? The canal is no longer the commercial necessity it once was. Global Positioning Systems and other navigational advances have made circumnavigating the Cape safe; the shoals that were once a menace to shipping are today easy to avoid. How might use of the canal change in the future?

If the Army Corps of Engineers has not considered all angles of alternatives to replacing the bridges, it should. Taxpayers should demand it. At $1 billion, no one should accept the status quo.



© 2019 BOURNE ENTERPRISE
All Rights Reserved.

For reprints or rights, please contact the publisher

Daily Times Chronicle

Date: Tuesday, November 05, 2019
Location: WOBURN, MA
Circulation (DMA): 5,700 (9)
Type (Frequency): Newspaper (D)
Page: 8
Section: Sports
Keyword: U.S. Army Corps of Engineers

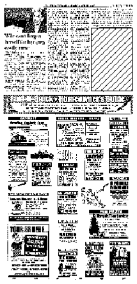
Cape Cod Canal bridges seek public input on upgrades

CONCORD - The U.S. Army Corps of Engineers, New England District, has extended the public comment period through Friday, November 15 for public input to the recommendation in the Cape Cod Canal Highway Bridges Major Rehabilitation Evaluation Study on the future of the highway bridges spanning the Cape Cod Canal in Bourne.

The Corps recommendation, documented in the draft Major Rehab Evaluation Report, is to replace the Bourne ad Sagamore highway bridges with new structures to include the 4 authorized travel lanes and 2 additional auxiliary lanes, designed as acceleration/deceleration lanes built to modern highway standards with appropriate bike/pedestrian access.The Draft Major Rehabilitation Evaluation Report (MRER) and Draft Environmental Assessment are available for review on the website at https://www.CapeCodCanalBridgeStudy.com under the "Documents" tab. The Corps will accept public comments on the recommendation contained within the draft bridge study through November 15, 2019.

The two bridges are major go-through bridges for motorists from the Greater Boston area, as well as New England, the East Coast, Canada and elsewhere. Much interest and concern has been expressed over the efficiency of the two bridges for decades.

The Corps will accept public comments on the draft study through November 15. Public comments can be e-mailed (see above) or mailed to U.S. Army Corps of Engineers, New England District (Attn: Craig Martin), 696 Virginia Rd., Concord, MA 01742-2751, or also to nae-pn-nav@usace.army.mil.



© 2019 DAILY TIMES CHRONICLE
All Rights Reserved.

For reprints or rights, please contact the publisher

REPUBLICAN

Date: Monday, October 07, 2019
Location: SPRINGFIELD, MA
Circulation (DMA): 57,755 (109)
Type (Frequency): Newspaper (D)
Page: 1
Section: Living
Keyword: U.S. Army Corps of Engineers

SOUND OFF

U.S Army Corps of Engineers recommends replacing the Sagamore, Bourne Bridge to Cape Cod; would require 310 days of closures: “85 years ago it took them just 2 years from start to completion with 1930’s technology to build both the Sagamore and Bourne bridges at approximately the same time. After reading the forecasted timeframes for the replacement bridges, we have not come very far. Sad.” – 1ifbyland on **masslive.com**

© 2019 REPUBLICAN
All Rights Reserved.

For reprints, please contact Kathy Greany, The Republican, P.O. Box 1329, Springfield, MA 01102-1329; (413) 735-1645 ; kgreany@repub.com

OLD COLONY MEMORIAL

Date: Wednesday, October 09, 2019
Location: PLYMOUTH, MA
Circulation (DMA): 4,453 (7)
Type (Frequency): Newspaper (2WK)
Page: A1,A13
Section: Main
Keyword: U.S. Army Corps of Engineers

Bridges to be replaced

Construction of new Cape bridges likely to impact Plymouth traffic

By David Kindy
dkindy@wickedlocal.com

There's a lot to be done before crossing these bridges, but planning is already underway following the announcement that the Army Corp of Engineers recommends replacing the two roadway spans over the Cape Cod Canal. If and when that happens, it will likely have an impact on Plymouth traffic.

"There's not a lot of information at this point, but we know it will have a big impact," said Lee Hartmann, director of Planning and Development in Plymouth. "When the flyover was constructed at the Sagamore Bridge in 2006, it definitely affected traffic on Bourne Road, Buttermilk Bay, Exit 2 at Cedarville and along Herring Pond Road."

The Corps of Engineers would like to begin replacing the Sagamore and Bourne bridges in 2025. In preparation for that, it has scheduled a series of meetings to present project plans and solicit comments from the public. The Plymouth session will be held Thursday, Oct. 17, beginning at 6 p.m. in the Performing Arts Center at Plymouth South High School.

Estimated cost to replace both bridges is more than $1 billion. According to state Rep. Randy Hunt, R-Sandwich, whose district includes Precinct 9 in Plymouth, current projections are $625 million for the Bourne Bridge and $415 million for the Sagamore Bridge.

See BRIDGES, A13

"Obviously, we will have to compete for funding with other federal construction projects, but our congressional delegation will be pushing that whole issue," he said.

Hunt cited evacuation safety of residents and visitors on Cape Cod for the need to do the project.

"Some 225,000 people live year-round on the Cape," he said. "That population swells to more than 4 million during the summer. If something happens, we need to evacuate everyone safely."

The bridges are nearly 85 years old and need considerable repair to maintain them. If they are not replaced, a major rehabilitation project will be needed to keep them safe. Hunt said that would be expensive and would do little to alleviate traffic congestion on and off Cape Cod.

"During repair work, one bridge would need to be shut down for a period of time and traffic rerouted to the other bridge," he said. "It would be a nightmare and a huge hit to the economy, because people would stay away."

Current plans call for the bridges to be built on the "inside" of the existing spans. The new Sagamore Bridge would be constructed just to the west of the current site, while the new Bourne Bridge would be erected just to the east of that location. Both existing bridges would be left in place while new construction takes place, and repair work would still be needed as part of regular safety and maintenance efforts.

The Army Corps of Engineers wants to increase the size of the lanes on the bridges to 12 feet from the 10 feet on the current spans. It also plans to add access lanes to speed traffic through the area, and include bike and pedestrian lanes. Work on the new bridges could start as early as 2025 and would take two-three years to complete.

Plymouth will monitor the project closely to make sure the impact on local traffic is not disruptive. When major construction was done on the Sagamore Bridge in 2006, town roads and villages noticed an uptick in congestion as drivers heading to and from the Cape tried to avoid the work areas.

"What with Waze and other apps, people will be traveling through the town and taking shortcuts," Hartmann said. "We'll be looking for ways to minimize that impact."

Hunt said there is a long way to go before construction starts. The project still must be designed, funded and approved by numerous federal and state regulatory agencies. However, he is hopeful work on the bridges can be started soon and completed quickly.

"It's an accelerated timeline," he said. "They replaced a collapsed bridge in Minneapolis in 19 months, so it can be done."

© 2019 OLD COLONY MEMORIAL
All Rights Reserved.

For reprints or rights, please contact the publisher

Martha's Vineyard The TIMES

Date:	Thursday, October 10, 2019
Location:	VINEYARD HAVEN, MA
Circulation (DMA):	13,556 (9)
Type (Frequency):	Newspaper (W)
Page:	A3
Section:	Main
Keyword:	U.S. Army Corps of Engineers

Army Corps of Engineers recommends Bourne, Sagamore bridge replacements

The Army Corps of Engineers has recommended that the 84-year old "functionally obsolete" Bourne and Sagamore bridges be replaced with new structures, according to the Cape Cod Canal Highway Bridges Major Rehabilitation Evaluation Study.

"Our recommendation, documented in the draft Major Rehab Evaluation Report, is to replace the Bourne and Sagamore highway bridges with new structures built to include the four authorized travel lanes and two additional auxiliary lanes designed as acceleration/deceleration lanes built to modern highway standards, with appropriate bike/pedestrian access," District Engineer Col. William Conde, commander of the U.S. Army Corps of Engineers, New England District, said in the release.

The report also states that the replacement of both bridges is expected to cost upwards of $1 billion. Currently both bridges are scheduled for major rehabilitation — the Sagamore Bridge in 2025 to 2027, and the Bourne Bridge in 2029 to 2031. Sagamore has an estimated cost of $185 million, while Bourne is expected to cost $210 million.

The draft Major Rehabilitation Evaluation Report (MRER) and draft environmental assessment are available for review on the Corps website.

The Corps is accepting public comments on the recommendations through Nov. 1. The study is to determine whether major rehabilitation or replacement of one or both of the bridges will provide a "reliable, fiscally, and environmentally responsible solution for future access across the Canal and Cape Cod," according to the release.

After the comment period, the Corps will address issues and concerns and finalize documents ahead of making a decision. An independent external peer review of the private and academic sectors will also review the report to advise on whether the bridges need to be replaced or can be repaired. The final MRER will be submitted to Corps headquarters in Washington D.C. for a February 2020 decision.

The MRER considers four major alternatives in its analysis: take no action and continue to repair bridges as needed, major rehabilitation of the bridges with routine maintenance, replacement of each bridge with a new structure with four lanes and bike and pedestrian access, or replacement of each bridge with a new structure with four lanes, bike and pedestrian access, and two auxiliary lanes.

Public meetings for the MRER bridge study are scheduled for the following dates:

Wednesday, Oct. 16, at Bourne High School auditorium, 75 Waterhouse Rd., Bourne.

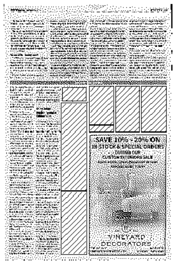
Thursday, Oct. 17, at Plymouth South High School Performing Arts Center, 490 Long Pond Rd., Plymouth.

Monday, Oct. 21, at the Thomas P. O'Neill Jr. Federal Building auditorium, 10 Causeway St., Boston. Registration and open house at 1 pm. Meeting starts at 1:30 pm.

Tuesday, Oct. 22, Nauset Regional High School auditorium, 100 Cable Rd., Eastham.

Wednesday, Oct. 23, Barnstable High School Performing Arts Center, 744 West Main St., Hyannis.

Comments can also be made online at capecodcanalbridgesstudy.com, emailed to nae-pn-nav@usace.army.mil, or mailed to U.S. Army Corps of Engineers, New England District, (Att'n: Craig Martin), 696 Virginia Rd., Concord, MA 01742-275. MVT



© 2019 MV TIMES
All Rights Reserved.

For reprints or rights, please contact the publisher

The Falmouth Enterprise
Date: Friday, October 18, 2019
Location: FALMOUTH, MA
Circulation (DMA): 8,738 (9)
Type (Frequency): Newspaper (W)
Page: 2
Section: Main
Keyword: U.S. Army Corps of Engineers

Army Corps Recommends New Canal Bridges

By MICHAEL J. RAUSCH

A draft report by the Army Corps of Engineers recommends replacing the Bourne and Sagamore bridges over the Cape Cod Canal.

The Army Corps announced October 3 that its Draft Major Rehabilitation Evaluation Report will recommend replacement of the two aging spans as opposed to continued repairs.

"The USACE has determined that there is sufficient justification for pursuing a program of bridge replacement for both the Bourne and Sagamore highway bridges over the Cape Cod Canal," the report stated.

According to the Corps, the study "has determined that providing two new highway bridges would be the most cost-effective means of providing safe and reliable crossings. The existing bridges are 85 years old and are functionally obsolete."

The Corps owns the bridges, which it built between 1933 and 1935.

Colonel William Conde, commander of the US Army Corps of Engineers for the New England District, said the draft report recommends new structures that will include four travel lanes and two acceleration/deceleration lanes "built to modern highway standards."

The bridges would also be built "with appropriate bike/pedestrian access," the colonel said.

The Corps has scheduled five public meetings this month on the draft report recommendations.

The first will be held next Wednesday, October 16, at 6 PM in the auditorium at Bourne High School. The Corps invites the public to attend and provide input on the draft report.

Replacing the bridges, instead of continuing to repair them, also was the recommendation of MassDOT's Cape Cod Canal Region Transportation Study Group.

The study group issued the results of its five-year study in February.

The existing bridges were constructed 85 years ago. They were built to replace two earlier bridges that had proven to be problematic.

The original Bourne and Sagamore bridges were drawbridges that were electrically operated, and, when opened, provided a 140-foot navigational clearance.

However, the swift current of the canal proved dangerous for vessels waiting for the drawbridges to be opened.

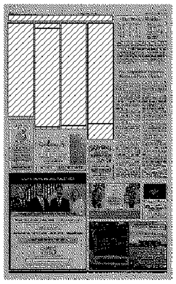
Fear among mariners led to an underwhelming number of vessels passing through the canal in its first few years, causing it to be deemed a failure.

During World War I, President Woodrow Wilson ordered the canal taken over by the Federal Railroad Administration. After the war, it was returned to the control of original owner August Belmont, but it became apparent that improvements needed to be made to the canal bridges.

In 1928, under authority of the federal Rivers and Harbors Act of 1927, the Army Corps took over operation of the Cape Cod Canal. The Army Corps widened and deepened the canal, and constructed three new bridges: the Bourne and Sagamore vehicular bridges, and the Buzzards Bay railroad bridge.

A Boston Sunday Globe article reported that 1,200 men worked on building the bridges, and roughly 2,000 men worked in the Pennsylvania steel mills, making the pieces used in construction.

Workers were both skilled and unskilled. Skilled laborers earned $1.50 an hour, while un-



© 2019 FALMOUTH ENTERPRISE
All Rights Reserved.

skilled workers made 50 cents an hour.

One of the more significant additions to the bridges was the installation of railing to cut down on the suicides and suicide attempts. In 1977 alone, nine people took their lives jumping from the two bridges. Repeated suggestions to make the bridges safer were made by the Samaritans of Cape Cod, a non-denominational, nonprofit volunteer organization that provides emotional support to the lonely, depressed, or suicidal.

In 1981 the Army Corps agreed to install the eight-feet-high railings now in place on the bridges.

In recent years, the Bourne and Sagamore bridges have required increasingly more frequent repair and maintenance, which is costly and causes significant slowdowns for traffic crossing the Cape Cod Canal.

In spring last year the Sagamore Bridge underwent extensive repairs that required lane closures and caused traffic gridlock. News of the work to be done drew a harsh rebuke from Cape Cod Chamber of Commerce CEO Wendy K. Northcross, as well as other chamber members and members of the Cape business community.

That community criticized the Army Corps for scheduling the bridge work during the Cape's shoulder season when businesses are gearing up for the busy summer months. Similar outrage was expressed when repairs and commuter snarls were the result of work done on the Bourne Bridge this past spring.

Ms. Northcross and other chamber members have established Coalition for the Fix, an advocacy group lobbying in favor of having the two canal bridges replaced in order to avoid the periodic repairs they say jeopardizes business on the Cape.

Wider bridges will allow for a freer flow of traffic and make it easier for people who live and work on the Cape to get their children to school, or aging parents to a doctor appointment, she said.

"The whole point of the project is to create a more reliable transportation system for Cape residents primarily, but also for visitors," Ms. Northcross said.

Judith M. Froman, chairman of the Bourne Board of Selectmen, suggested that wider lanes might increase the speed at which people travel over the bridges. That, in turn, could be helpful in keeping traffic flowing over the bridges, Ms. Froman said.

Wider bridges, she said, could also mean more room for drivers to react to an unexpected event.

"It is amazing to me how often people slow down to look at the view and they cause accidents," Ms. Froman said. "Maybe we need a viewing tower like at the Penobscot Stonington bridge in Maine."

The Corps said it will accept public comments on the recommendations in the study through Friday, November 1. In addition to next Wednesday's meeting at Bourne High, other Cape meetings will be held: on Thursday, October 17, at Plymouth South High School Performing Arts Center; Tuesday, October 22, at Nauset Regional High School in Eastham; and Wednesday, October 23, at the Barnstable High School Performing Arts Center in Hyannis. Those meetings also begin at 6 PM.

The fifth meeting is scheduled for Monday, October 21, at 1 PM, at the Thomas P. O'Neill Jr. Federal Building on Causeway Street in Boston.

At the end of the public comment period, the Corps will address issues raised by the public. In addition to public comment, the draft report will also undergo an independent external peer review by members of the private and academic sectors, the Corps

© 2019 FALMOUTH ENTERPRISE
All Rights Reserved.

said.

A final recommendation on whether to replace or continue to repair the Cape Cod Canal bridges will be contained in the final report that will be submitted to Corps headquarters in Washington, DC, in February 2020.

© 2019 FALMOUTH ENTERPRISE
All Rights Reserved.

CAPE COD TIMES
capecodONLINE.com

Date: Tuesday, October 08, 2019
Location: HYANNIS, MA
Circulation (DMA): 19,153 (7)
Type (Frequency): Newspaper (D)
Page: 1,4
Section: Main
Keyword: U.S. Army Corps of Engineers

Army Corps considered a dozen bridge options

Abandoned ideas included filling in the canal, building a third bridge and, yes, a tunnel

By Ethan Genter
egenter@capecodonline.com

CONCORD — The tunnel permit sticker is one of the mainstays of Cape Cod jokelore, but the idea of a tunnel actually was considered by the U.S. Army Corps of Engineers in its major study of options for the Bourne and Sagamore bridges.

The study, released last week, showed that the Corps, which maintains and operates the two bridges, analyzed 12 scenarios, including a tunnel, filling in the canal and the construction of a third bridge.

In the end, the Corps recommended building two new bridges adjacent to the existing ones, with wider lanes, shoulders, auxiliary lanes and a median. But the other ideas, some of which have long been fodder for locals, got serious consideration by the Corps in its more than three-year study.

See BRIDGES, A4

The initial 12 were evaluated and screened to eliminate those that were impractical based on cost, effects on marine and land transportation and other factors.

Three ideas were immediately dismissed: the filling in of the canal and two plans that would replace the bridges with causeways and drawspans.

“These alternatives would degrade the efficiency and safety of coastwise navigation as some or all of the Canal’s marine traffic would be diverted to the Atlantic shipping routes to the south and east of the Cape, Islands, and Nantucket Shoals,” the Corps wrote in the draft report.

This would increase risk and shipping cost and need legislative approval because the canal is a mandated deep-draft waterway.

Plans for tunnels also were nixed because costs were estimated to be at least twice the approximately $1 billion price tag for new bridges. The Corps also determined tunnels would have an extensive impact on the environment and land use.

Plans to replace both bridges with a single bridge, or the construction of a third automobile bridge, also were abandoned because of the costs, the extensive work it would take to connect the bridge to existing roads, and the impact on the environment, homes and businesses in the area.

Ideas to build one or more new bridges with more than four through-traffic lanes were the last to be eliminated. The existing bridges are four lanes wide, and the Corps would need federal legislative approval to expand capacity.

This left four alternatives, although only three were actually considered because the first option — basically to do nothing and repair the bridges when necessary — was kept only as a baseline comparison.

Those three remaining options were major rehabilitation of the bridges, replacement of the bridges with four lanes, or replacement of the bridges with four through-traffic lanes plus two auxiliary lanes.

A rehabilitation, which would be needed for both bridges between 2025 and 2031, would result in six months of complete closure for the Bourne Bridge and more than four months of closure for the Sagamore Bridge. Partial lane closures were pegged at 480 days for the Bourne and 380 for the Sagamore.

The Corps has said to expect minimal disturbances from the new construction, although the existing bridges still will need regular maintenance during that time.

In the end, the Corps recommended the proposal of four through lanes and two auxiliary lanes, saying that, in general, new bridges would be more cost-effective than continuing to maintain the existing ones.

The Corps' analysis pointed out that a four-lane bridge would cost less than a four-lane bridge with an auxiliary lane, but, considering the state's recent recommendations for changes to the roads leading to the bridges, the latter would be better.

“If the state chooses to improve the road network surrounding the bridges as suggested in the draft Cape Cod Transportation Study, particular near the Bourne Rotary and the improvements to Route 6, then the replacement bridges that include the auxiliary on/off lanes will provide additional efficiency benefits of improved travel time by allowing the left-hand

© 2019 Dow Jones Local Media Group, Inc.
All Rights Reserved.

For reprints or reuse, please e-mail sean.polay@dowjones.com or
send a letter to Sean Polay, Dow Jones Local Media Group, Box 580, Middletown, NY 10940

travel lanes to be fully used by through traffic, since exiting and entering traffic would use the acceleration/deceleration lanes," the Corps found.

On Monday, MassDOT announced it had finalized its study of changes to roads and rotaries leading to the bridges. MassDOT officials said last week they were proceeding with the initial stages of some of the projects.

The state plan calls for improvement and expansion of bicycle and pedestrian facilities, upgrades at the Bourne Rotary, interchange investments at Belmont Circle, relocating the Route 6 westbound Exit 1C and adding an additional Route 6 eastbound travel lane from the canal to approximately Exit 2.

"MassDOT has been working closely with the U.S. Army Corps of Engineers because we both share the responsibility of ensuring that the public can safely and efficiently travel between the Cape and the mainland," state Transportation Secretary Stephanie Pollack said in a statement. "As we each take steps to replace transportation infrastructure we own, we will be carefully looking at the timing of scheduled construction so that the work is sequenced in such a way so that the public can still come and go for work, for pleasure or for vacation."

Glenn Cannon, the acting town administrator for Bourne and a former transportation official with the Cape Cod Commission, said it was good that the Corps explored all of the possible options, even if they were as far-fetched as filling in the canal.

"They did a very good job," he said. "I think it's the right way to do it. ... You don't leave any stone unturned."

Follow Ethan Genter on Twitter: @EthanGenterCCT.

© 2019 Dow Jones Local Media Group, Inc.
All Rights Reserved.

For reprints or reuse, please e-mail sean.polay@dowjones.com or
send a letter to Sean Polay, Dow Jones Local Media Group, Box 580, Middletown, NY 10940

CAPE COD TIMES
capecodONLINE.com The Cape and Islands' Daily Newspaper

Date: Tuesday, October 08, 2019
Location: HYANNIS, MA
Circulation (DMA): 19,153 (7)
Type (Frequency): Newspaper (D)
Page: 1,4
Section: Main
Keyword: U.S. Army Corps of Engineers

A study released last week by the U.S. Army Corps of Engineers shows that at least 12 scenarios were analyzed in making the decision to replace both the Bourne and Sagamore bridges. [MERRILY CASSIDY/ CAPE COD TIMES FILE]

© 2019 Dow Jones Local Media Group, Inc.
All Rights Reserved.

For reprints or reuse, please e-mail sean.polay@dowjones.com or
send a letter to Sean Polay, Dow Jones Local Media Group, Box 580, Middletown, NY 10940

The Boston Globe

Date: Saturday, October 05, 2019
Location: BOSTON, MA
Circulation (DMA): 235,236 (7)
Type (Frequency): Newspaper (D)
Page: A1,A10
Section: Main
Keyword: U.S. Army Corps of Engineers

A $1 billion fix for Cape bridges long past their prime

Army Corps of Engineers calls for two new spans to replace Bourne, Sagamore

By Andy Rosen
GLOBE STAFF

The federal government is calling for a complete replacement of the two bridges that cross the Cape Cod Canal, a long-awaited decision that will reshape a crossing that has frustrated generations of travelers between the Cape and mainland.

The US Army Corps of Engineers has released a draft recommendation for a $1 billion replacement of the Bourne and Sagamore crossings, which were built 84 years ago and intended to last a half-century.

The agency, which controls the bridges, had deliberated for years over what to do about the structures, which are in poor condition and increasingly need major maintenance work that itself creates major traffic headaches. The Army Corps considered a range of proposals, from different bridge configurations, to tunnels, to causeways — even the idea of filling in the canal and directing marine traffic around the Cape.

In the end, officials decided the most practical solution is two new bridges next to the existing spans, likely on the inland side of each. The bridges would have four travel lanes, two added lanes for merging traffic, and, unlike the current crossings, a median separating the on-Cape and off-Cape-bound traffic. The current structures would remain in service until the new bridges open to traffic.

BRIDGES, Page 10

“This is the best-case scenario,” said Wendy Northcross, chief executive of the Cape Cod Chamber of Commerce. She said the bridge work, combined with a massive project by the state to improve roads and intersections leading on and off the Cape, could make a huge difference.

Northcross said that even though the bridge replacement may bring significant traffic disruption at times, the alternative that would have required closing the existing bridges and rehabilitating them in succession would have made it nearly impossible for people to come and go.

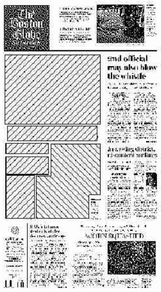
“That would have been tragic,” she said. “That would have been an economic hit to the solar plexus.”

The Army Corps said the bridges have gotten to the point where it is more economical to replace them than fix them. And the need for improvement is great; the corps released a set of pictures from the bridge that included unnerving conditions of pitted concrete and rusted metal.

“As the bridges and their components continue to age, the cost of operation and maintenance and periodic rehabilitation slowly escalates,” the Corps said in its report, describing the existing structures as “functionally obsolete.”

The Army Corps has not laid out a timeline for the replacement. The next steps include holding five public meetings through October on the Cape and in Plymouth and Boston, and accepting public comments until Nov. 1. It hopes to finalize its recommendation early next year.

However, the agency will likely want to move quickly to head off costly repairs scheduled in coming years. The Sagamore Bridge is scheduled for a $185 million rehabilitation as early as 2025, while the Bourne Bridge would undergo a similar, $210 million project as soon as 2029.



© 2019 BOSTON GLOBE
All Rights Reserved.

For reprints or rights, posters and plaques, please visit www.GlobeReprints.com or call (212) 221-9595

Though the Army Corps has not commissioned detailed designs, preliminary details for the federally funded project suggest the new structures could be twice as wide as the existing spans, which have 46-foot roadways.

The new bridges' travel lanes would be 12 feet wide; the existing travel lanes are 10.

Other additions intended to improve travel flow include the merging lanes, shoulders on both sides, and the median. The bridges would also have improved bike and pedestrian access.

For people who live on the Cape, where traffic congestion is much more than a frustrating obstacle on the way to vacation, relief can't come soon enough.

Angela Dalpe, who has lived in Sandwich for a decade, said she wishes the Corps could keep the two existing bridges along with the new ones.

Dalpe, a nurse who works in corrections in Bristol County, said her commute can take as little as 45 minutes —"That's using my best back roads" — but it can easily take twice as long. Bridge traffic, especially in summer, can make her commute so unpredictable that she sometimes has to decline shifts.

"It turns me into an unreliable employee," she said. "When it's Labor Day weekend, and I have to go over the bridge, and I don't know how long it's going to take me to get there, I just have to say I can't come in."

The bridge replacement plan had been widely anticipated. Massachusetts transportation officials are already making plans to rework the state roads that lead to and from the bridges. That work alone could cost $350 million over several years, according to preliminary estimates.

Officials believe the projects together will ultimately lead to easier drives through the notoriously congested area. They say they will do everything they can to minimize the disruptions while the work is happening.

"Our starting point on any big project is making sure that we are having the least impact on the traveling public as possible," said Jonathan L. Gulliver, highway administrator for the state Transportation Department.

The Army Corps' plan got early applause from the congressional delegation representing the Cape. In a statement, Senators Edward J. Markey and Elizabeth Warren, and Representative William R. Keating praised the agency's recommendation.

"Two new bridges built up to modern standards will improve traffic flow, allow better access to the Cape and Islands in the coming years, and provide vital evacuation routes," Keating said. "As a year-round resident of Cape Cod who depends on the Bourne Bridge, I strongly feel that this is the best outcome for our Cape and Islands community and the greater Southeastern region as a whole."

The bridge replacement is another huge infrastructure project for Massachusetts. In Boston, where memories of the Big Dig remain fresh, the state is working toward a $1.1 billion reconstruction of the Massachusetts Turnpike's Allston interchange — a project that will open a huge area for new development, but will also involve eight years of construction and traffic disruption.

The Cape bridge construction will have many complexities as well. The projects would likely require the Army Corps to acquire land adjacent to the bridges, including some that currently is home to a Market Basket plaza near the Sagamore Bridge and a Dunkin' Donuts near the Bourne crossing. In total, the report estimates that the projects would require 15 acres, and cost more than $15 million.

Even with the project, people on the Cape are realistic: Bridge traffic will never really go away during the

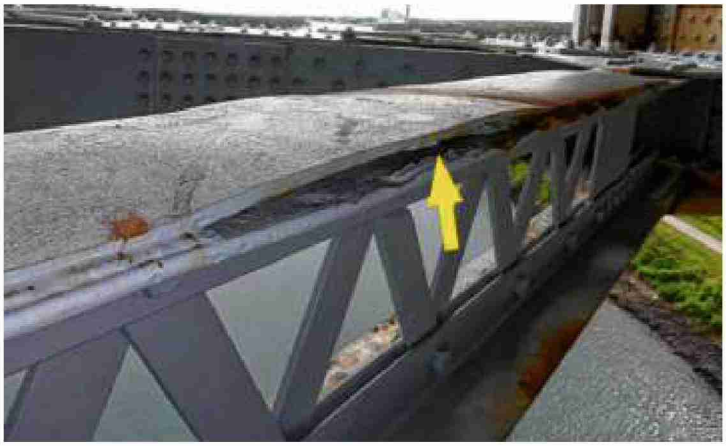
© 2019 BOSTON GLOBE
All Rights Reserved.

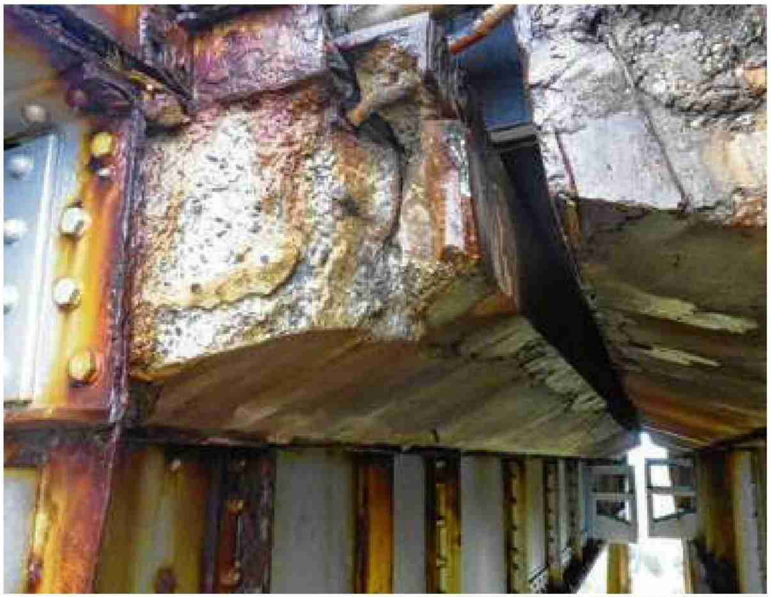
For reprints or rights, posters and plaques, please visit www.GlobeReprints.com or call (212) 221-9595

high season. But it might not get worse, either.

"If everyone still decides to come into the Cape on the same day, we should have some back-ups," Northcross said. "But for most of the year, this should handle quite nicely. We're unclogging the clog, if you will."

Andy Rosen can be reached at andrew.rosen@globe.com.





The report highlighted a cracked weld on the Sagamore (above) and a rusted joint under the Bourne.

US ARMY CORPS OF ENGINEERS PHOTOS

© 2019 BOSTON GLOBE
All Rights Reserved.

For reprints or rights, posters and plaques, please visit www.GlobeReprints.com or call (212) 221-9595

JOHN TLUMACKI/GLOBE STAFF

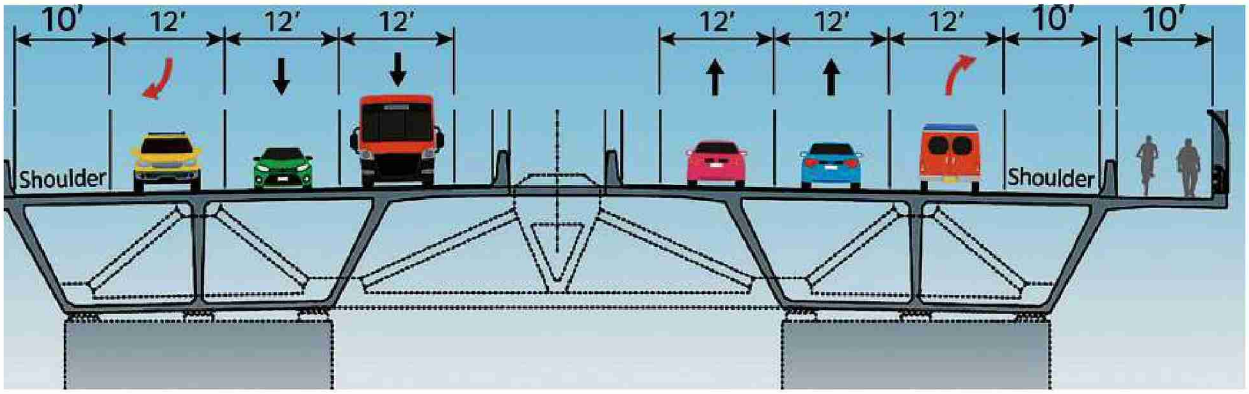
The Sagamore Bridge would continue to operate while a new one was being built nearby.

GLOBE FILES

The Bourne Bridge opened for cars and pedestrians in June 1935. It was intended to last for 50 years.

© 2019 BOSTON GLOBE
All Rights Reserved.

For reprints or rights, posters and plaques, please visit www.GlobeReprints.com or call (212) 221-9595



US ARMY CORPS OF ENGINEERS

Preliminary designs for the bridges feature four travel lanes with additional merging lanes, as well as medians.

© 2019 BOSTON GLOBE
All Rights Reserved.

For reprints or rights, posters and plaques, please visit www.GlobeReprints.com or call (212) 221-9595

THE REGISTER

Date: Thursday, October 24, 2019
Location: YARMOUTH PORT, MA
Circulation (DMA): 5,085 (9)
Type (Frequency): Newspaper (W)
Page: A7
Section: Main
Keyword: U.S. Army Corps of Engineers

Army Corps considers turning bridges over to state

The U.S. Army Corps of Engineers has talked about handing over control of the Bourne and Sagamore bridges to the state after replacing them.

"That's definitely something that's been in discussion," Craig Martin, the Corps' project manager in the New England District, said Oct. 17.

The Corps released a draft report earlier this month recommending the bridges be replaced, and it is currently seeking public input on the potential project. Since the Corps has not definitely decided on replacement, no official memorandum of understanding between the Corps and the state has been made, he said.

Martin

"Nothing has been formalized," Martin said.

The bridges are the only two links for vehicles between the mainland and Cape Cod but are not what is typically found in the Corps' portfolio. The federal government acquired the Cape Cod Canal in 1928 and was authorized to build the bridges in 1933. The bridges were completed in 1935 and, at 84 years old, no longer meet modern roadway standards.

Most of the Corps bridges across the country are much smaller than the Bourne and Sagamore spans and normally connect to other infrastructure, such as dams.

"Typically the Corps doesn't manage traffic bridges like these," spokesman Timothy Dugan said.

A bridge similar to the Cape crossings that the Corps manages is the Sen. William V. Roth Jr. Bridge, which spans the Chesapeake & Delaware Canal. That bridge was used as a model for the proposed cross-sections of the Bourne and Sagamore replacements.

"We really only have a handful of really large bridges," Martin said.

The idea of divesting the bridges to the Massachusetts Department of Transportation has been discussed because the bridges are such a critical link for the state road network and traffic bridges are not usually part of the federal agency's core mission, he said.

But creating such a memorandum of understanding between the Corps and the state could be a long way off.

"We have to get to the decision first," Martin said of bridge replacement.

The Corps is still taking public comments on its draft report, which recommends building two six-lane bridges adjacent to the existing spans. The comment period ends Nov. 1, and a final report is slated to be done in February. A decision on whether to replace the bridges is not expected until the spring.

The project would ultimately have to be included in the Corps budget and be approved by Congress.

Markey

Massachusetts Sens. Edward Markey and Elizabeth Warren and the Cape's congressional representative, William Keating, sent a letter to the Army Corps on Thursday urging the federal agency to provide all of the necessary funding to replace the bridges in its 2020 work plan.

"These bridges connect the nearly 250,000 residents on the Cape and Islands to the rest of Massachusetts and connect the rest of the country to this beating heart of the Massachusetts tourism economy," the legislators' letter to Lt. Gen. Todd Semonite says.

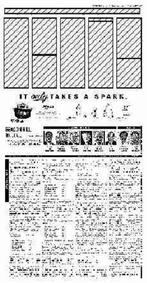
"We believe that the new draft report represents significant progress toward addressing the construction needs of these two critical infrastructure projects, and ask that you devote the full resources necessary for completing this vital work," the letter states.

Allocating initial funds to solicit design and construction work would "represent a significant down payment and a responsible long-term investment in this critical infrastructure project."

The lawmakers also note a prospective divestment of the bridges to the state after their completion.

"We understand that the (Corps) will soon sign a memorandum of understanding with MassDOT that includes a plan to divest these federal bridges to state control after the (Corps') construction work is complete," they wrote. "The (Corps') investment of initial funds in FY 2020 will ensure that this process begins on schedule, avoids increasing costs brought on by project delays, and facilitates the state's takeover of these bridges as soon as possible. We applaud this goal because we believe it will lead to the best result for Massachusetts, while also helping to reduce the (Corp's) future workload and amounts spend on Operations and Maintenance."

The state Department of Transportation has a memorandum of understanding with the Corps that says the two agencies will collaborate through the project to replace the bridges, but it does not have a memorandum that specifies the department



© 2019 REGISTER
All Rights Reserved.

For reprints or rights, please contact the publisher

would take over ownership and maintenance of the two bridges, a department spokeswoman said via email.

Markey hopes to get all major players on the project together in the coming weeks, according to his office.

The topics mentioned in the lawmakers' letter are not on the Corps' plate at the moment, Dugan said.

"A lot of this is well beyond where we are at," he said. "Our focus is finishing the report."

© 2019 REGISTER
All Rights Reserved.

For reprints or rights, please contact the publisher

CAPE COD TIMES
capecodONLINE.com

Date: Friday, October 04, 2019
Location: HYANNIS, MA
Circulation (DMA): 19,153 (7)
Type (Frequency): Newspaper (D)
Page: 1,4
Section: Main
Keyword: U.S. Army Corps of Engineers

Army Corps: Replace canal bridges

Long-awaited study concludes replacement of aging spans more cost-effective than rehabilitation

By Ethan Genter
egenter@capecodonline.com

In a report released Thursday night, the Army Corps of Engineers recommended replacing the aging Bourne and Sagamore bridges, with construction possibly starting in 2025. The recommendation came in a draft version of the Corps' long-awaited Major Rehabilitation Evaluation Study, which weighed rehabbing the two 80-plus-year-old bridges against replacing them.

The Corps, which owns and maintains the bridges, determined that the price tag to replace them would be more cost-effective than the $1.5 billion it would take to rehabilitate them.

As recommended, the new bridges would have four travel lanes, two in each direction, and an auxiliary lane on both sides. There also are plans for a median, shoulders and a separate bike and pedestrian lane, which the current bridges do not have. The lanes also would be widened from 10 to 12 feet.

The existing bridges would remain open during construction and be demolished after the new bridges are finished. The new Sagamore Bridge would be built to the west of the existing bridge and the new Bourne Bridge to the east of that span.

During construction, the existing bridges will need additional maintenance, so there will still be interruptions to traffic.

The Cape Cod Canal was built in 1916 to cut down on travel times for ships heading south from Boston. The bridges were built about 20 years later, at a time when the Cape's population was about 26,000 people and vehicles were much smaller than the SUVs and trucks that cross the bridges every day now.

Both bridges are structurally deficient and do not meet modern-day standards.

See BRIDGES, A4

"The existing bridges were constructed 84 years ago and require increasingly more frequent repair and maintenance, which is costly and causes significant impact to traffic crossing the Cape Cod Canal," the Army Corps wrote in a statement.

With the release of the draft report, the Corps is kicking off a public comment period to start later this month. Public meetings will be held in Bourne, Plymouth, Boston, Eastham and Hyannis.

The Corps will review those comments and then finalize its report and give its decision, possibly by spring.

That timeline could provide for construction to start in 2025.

The final report will be submitted to Corps headquarters in Washington, D.C,. for a decision in February.

Public comments on the report will be taken through Nov. 1.

The Massachusetts Department of Transportation came to a similar conclusion about the bridges in May. After a five-year study, the state proposed bridges that were 138 feet wide — 90 feet wider than the existing ones. The department envisioned each bridge with six 12-foot lanes, a 10-foot-wide median, a 12-foot-wide shared-use path and a 6-foot sidewalk on either side.

The state also recommended revamping several of the roads leading to the bridges; bonds for that work were proposed in Gov. Charlie Baker's $18 billion bond bill earlier this year.

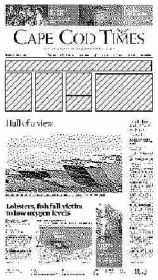
A hearing on that bill is scheduled for Oct. 8, Cape Cod Regional Transit Authority Administrator Thomas Cahir said.

There are multiple bills in Congress that could help pay for the bridges, including a $5 million amendment in an appropriations bill that would pay for their design and a $1 billion bill that would bolster the nation's evacuation routes, of which the bridges are a component.

Rehabilitation of the bridges was estimated to take 3½ years and result in temporary and full closures.

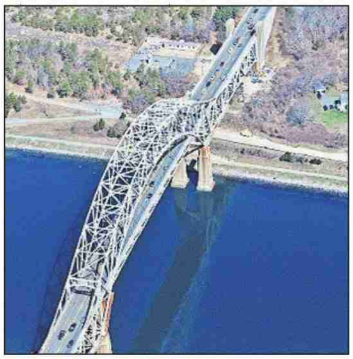
Follow Ethan Genter on Twitter: @EthanGenterCCT.

As recommended by the Army Corps of Engineers, the new bridges would have four travel lanes, two in each direction, and an auxiliary lane on both sides. There also are plans for a median, shoulders and a separate bike and pedestrian lane, which the current bridges do not have. The lanes also would be widened from 10 to 12 feet.



© 2019 Dow Jones Local Media Group, Inc.
All Rights Reserved.

For reprints or reuse, please e-mail sean.polay@dowjones.com or
send a letter to Sean Polay, Dow Jones Local Media Group, Box 580, Middletown, NY 10940



An aerial view of the Sagamore Bridge as traffic backs up heading on to the Cape. The Army Corps of Engineers, which owns and maintains both vehicular bridges over the canal, has recommended replacing them. [STEVE HEASLIP/CAPE COD TIMES]

Traffic backs up on the Bourne Bridge heading into the rotary during one of the increasingly frequent maintenance and construction projects. [STEVE HEASLIP/CAPE COD TIMES]

© 2019 Dow Jones Local Media Group, Inc.
All Rights Reserved.

For reprints or reuse, please e-mail sean.polay@dowjones.com or
send a letter to Sean Polay, Dow Jones Local Media Group, Box 580, Middletown, NY 10940

The Enterprise

Date: Saturday, November 02, 2019
Location: BROCKTON, MA
Circulation (DMA): 6,500 (9)
Type (Frequency): Newspaper (D)
Page: 1
Section: Main
Keyword: U.S. Army Corps of Engineers

STATE

DEADLINE EXTENDED FOR COMMENT ON CAPE COD CANAL BRIDGES PROJECT

The New England District of the Army Corps of Engineers has extended the deadline for public comment. Residents can make their thoughts known online, by email or via regular mail. The Corps of Engineers announced last month that it will recommend constructing two new spans to replace the Sagamore and Bourne bridges, which are nearly 85 years old.

PAGE 3

© 2019 ENTERPRISE
All Rights Reserved.

For reprints or rights, please contact the publisher

Kingston Reporter

Date: Friday, October 11, 2019
Location: PLYMOUTH, MA
Circulation (DMA): 1,061 (9)
Type (Frequency): Newspaper (W)
Page: A3
Section: Main
Keyword: U.S. Army Corps of Engineers

Local legislators share successes

Elected officials talk about efforts to help the region at Chamber breakfast

By David Kindy
dkindy@wickedlocal.com

What do you get when you take a bunch of politicians from both parties and throw them in a room together? Mutual respect and good-natured kidding.

That was the case at the 2019 Legislative Breakfast, presented Friday by the Plymouth Area Chamber of Commerce at the Hotel 1620 Plymouth Harbor. Instead of rancorous debate and name-calling, local politicians joked with each other and related how they work together to solve problems at the State House and in the district.

"Even though we come from different backgrounds, we're all friends," said state Sen. Vinny deMacedo. "We don't take it personally. We maintain decorum and agree to disagree."

The spirit of congeniality was evident throughout the Legislative Breakfast as each speaker - Democrat or Republican - supported their colleagues on a myriad of issues concerning local communities: economic development, gambling, transportation, tourism and more.

DeMacedo, R-Plymouth, led off the session by discussing how the Massachusetts Legislature has been working to increase funding for the Rainy Day Fund. The stabilization account has grown substantially in less than five years, from $1.8 billion in 2015 to $2.6 billion today. It is expected to reach $3.5 billion by 2020. The fund helps the state pay for important programs when tax revenues fall during economic decline, and a strong fund helps make for a strong financial rating.

"We have to be prepared," he said. "When things get bad, that's when you need the Rainy Day Fund. We're in a much better position now than we've ever been."

State Rep. Kathy LaNatra, D-Kingston, discussed a petition to the Office of Business Development to establish a MassMade program to identify, connect and support businesses that produce consumer goods in the commonwealth.

State Rep. Matt Muratore, R-Plymouth, talked about the "significant dollars" that have gone into infrastructure improvements to help Plymouth prepare for its 400th anniversary in 2020. He said the federal and state delegation worked together to secure $14 million for dredging Plymouth Harbor so larger cruise ships and other vessels can visit.

"The eyes of the country and the world will be on us," he said. "The focus will be on us all year and beyond 2020."

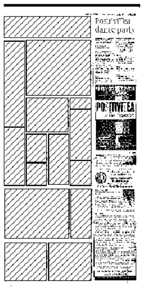
A racetrack and gambling proposal announced for Wareham was discussed by state Rep. Susan Williams Gifford, R-Wareham. She has filed legislation to have the Massachusetts Gaming Commission review the plans and determine its viability for Region C, which includes Southeastern Massachusetts.

"We want to know if the state can support another casino," she said. "Having this proposal reviewed by the commission will help us understand what we can sustain. This is the first step."

The impact of replacing the Sagamore and Bourne bridges over the Cape Cod Canal was discussed by state Rep. Randy Hunt, R-Sandwich.

On Thursday, the U.S. Army Corps of Engineers announced new bridges were necessary and it hoped to begin construction as early as 2025. He detailed the planned improvements, which include wider and additional lanes.

"These changes will help a lot," he said. "Traffic will move much more quickly, which will provide a lot of relief." He added, "Ten years from now, we could be using



© 2019 KINGSTON REPORTER
All Rights Reserved.

For reprints or rights, please contact the publisher

two new spans."

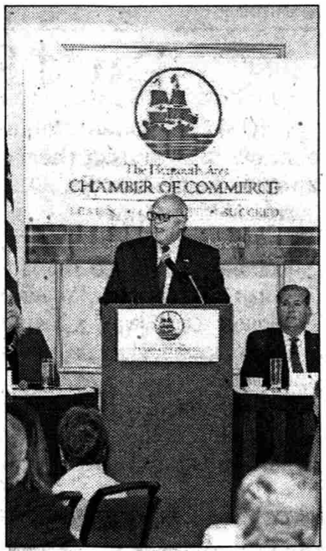
The challenge of dealing with the opioid crisis was the focus of Plymouth County District Attorney Tim Cruz' talk. Cruz, a Republican from Marshfield, described how the Plymouth County Drug Task Force has become a national model by working to reduce opioid deaths while getting referrals for addiction therapy are going up.

"Things are happening here," he said. "We've made a lot of progress, but there's still more we need to do with your help."

State Rep. Josh Cutler, D-Duxbury, discussed his role as a leader of the Workability Taskforce to study the critical issue of workforce development for persons with disabilities.

Register of Deeds John Buckley, D-Brockton, provided an update on the Registry's continuing efforts to enable the system to search land records back to 1686.

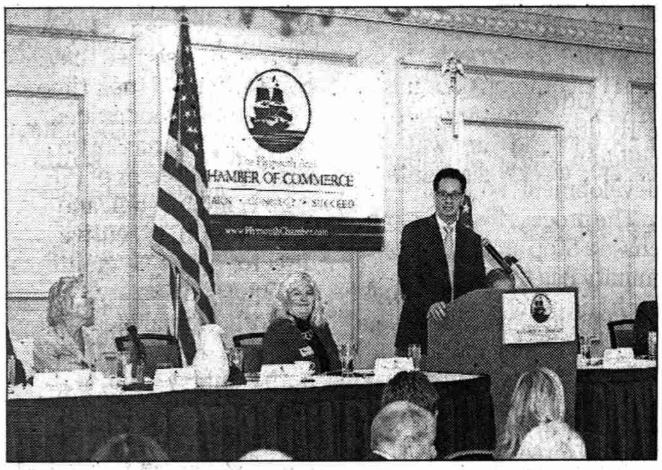
Plymouth County Sheriff John McDonald, R-Kingston informed the audience of a five-year deal with county commissioners to lease the County Farm land and continue it for agricultural and prisoner work programs.



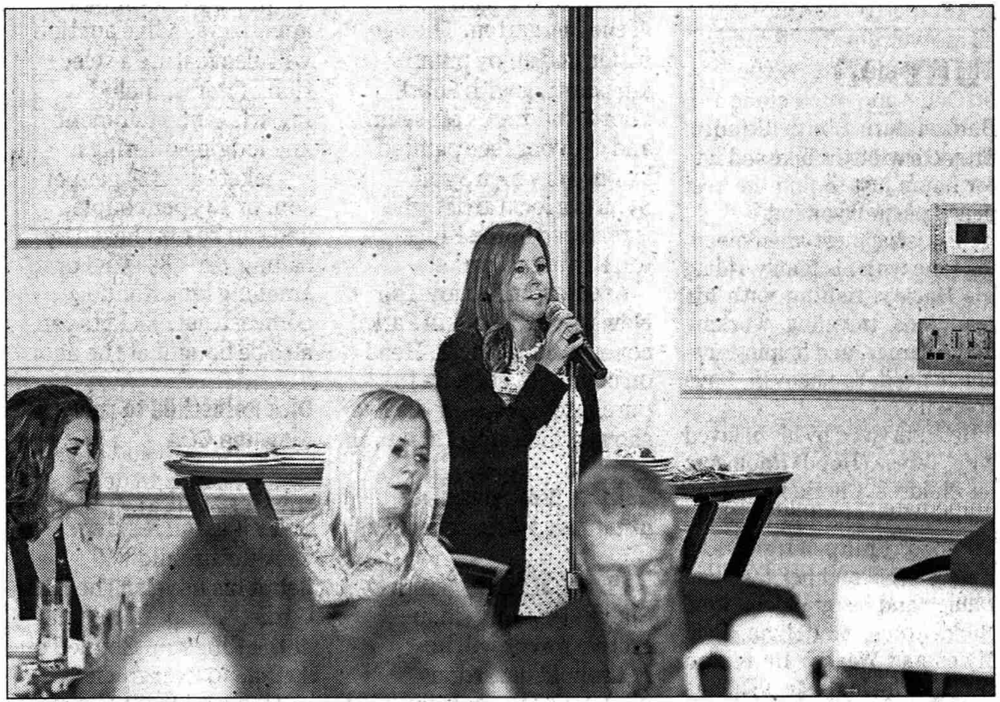
Plymouth County DA Timothy Cruz reported that Plymouth County's Drug Abuse Task Force's Outreach Program has resulted in a 26 percent decrease in fatal drug overdoses.

State Rep. Kathy LaNatra jokes with state Sen. Vinny deMacedo on her way to the podium where, she spoke about her, along with state Rep. Josh Cutler and others' petition that the Office of Business Development establish a MassMade program to identify, connect and support businesses that produce consumer goods in the commonwealth. [WICKED LOCAL PHOTO/DENISE MACCAFERRI]

© 2019 KINGSTON REPORTER
All Rights Reserved.

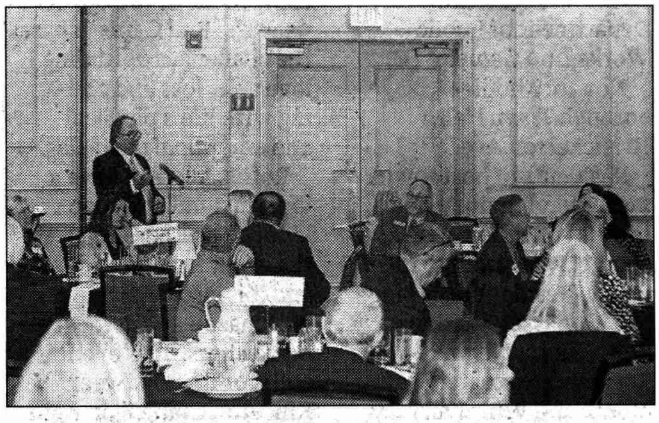


State Sen. Vinny deMacedo presents the state's healthy fiscal position.



Stacey Jordan, area manager at HomeBridge Financial, asks the legislators about the status of gender equality legislation.

© 2019 KINGSTON REPORTER
All Rights Reserved.



During the Q&A session of the Legislative Breakfast, PACC Board President Peter Brown asks the panel why bipartisanship works so well locally but not in Washington. The consensus of the panel was mutual respect, not taking things personally, and working together for the greater good of Plymouth and surrounding communities.

State Rep. Josh Cutler talked about his role as leader of the Workability Taskforce to study the critical issue of workforce development for persons with disabilities.

© 2019 KINGSTON REPORTER
All Rights Reserved.

BOURNE ENTERPRISE

Date: Friday, October 25, 2019
Location: FALMOUTH, MA
Circulation (DMA): 8,738 (9)
Type (Frequency): Newspaper (W)
Page: 4
Section: Main
Keyword: U.S. Army Corps of Engineers

Douglas K. Oesterheld
County Road
Monument Beach

Modular Canal Bridges

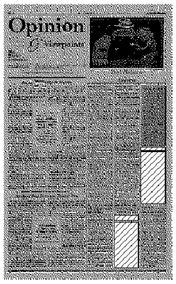
The Army Corps of Engineers has recommended replacing the Bourne and Sagamore bridges. The Massachusetts Department of Transportation (DOT) has concluded that the two bridges be replaced with two much-wider bridges, revamping the roads leading to the bridges.

As the new bridges would be built off to the sides of the current bridges, none of the current roadway infrastructure lines up with the proposed bridges, so there would need to be land taking and infrastructure changes. In effect, the new bridges are bridges to nowhere until all the infrastructure changes and environmental impacts are resolved.

From my engineering experience on a new project, one should have an alternate project plan (Plan B) in case the hoped-for conceptual design (Plan A) runs into a snag as a result of more definitive data and analysis. Plan B is offered based on a modular approach that would result in the same number of travel lanes and lane width as those in Plan A, but would have a smaller environmental and infrastructure impact.

In Plan B the DOT bridge in Plan A would be divided into two modules at the center median, so in effect we have southbound and northbound bridge modules. The approach to construction would be to line up one module with the existing roadways. Initial construction would be to place the first module alongside the existing bridge. After the first module is completed traffic would be temporarily routed away from the old bridge using the new bridge. The next step would be to remove the old bridge and then replace it with the second module. Now the second module is in line with the existing roadways, and the necessary land taking and the impacts on the infrastructure are reduced.

Philip T. Levine
Harbor Hill Drive
Bourne



© 2019 BOURNE ENTERPRISE
All Rights Reserved.

For reprints or rights, please contact the publisher

CAPE CODDER

Date: Friday, October 11, 2019
Location: ORLEANS, MA
Circulation (DMA): 5,380 (9)
Type (Frequency): Newspaper (W)
Page: A8
Section: Main
Keyword: U.S. Army Corps of Engineers

Hearings on the bridges

The U.S. Army Corps of Engineers has recommended replacing both the Bourne and Sagamore bridges, opening up a public comment period on what could shape up as a pair of major construction projects.

If advanced, the project will potentially expand the bridges to include four travel lanes and two additional acceleration and deceleration lanes. The existing bridges would remain open during construction and be demolished after the new bridges are finished. The new Sagamore Bridge would be built to the west of the existing bridge and the new Bourne Bridge, to the east of that span.

The 84-year-old bridges increasingly require more repairs and maintenance, the Army Corps indicated, which is costly and causes significant impact to traffic crossing the Cape Cod Canal. It determined that the estimated $1.5 billion to replace them would be more cost-effective than the similar amount it would take to rehabilitate them.

The Corps scheduled public meetings for Oct. 16 at Bourne High School; Oct. 17 at Plymouth South High School; Oct. 21 at 1:30 p.m. in the Thomas P. O'Neill Jr. Federal Building in Boston; Oct. 22 at Nauset Regional High School, and Oct. 23 at Barnstable High School.

It is accepting public comments on the draft study through Nov. 1, either at a public meeting, online at CapeCodCanalBridgesStudy.com, or via email to nae-pn-nav@usace.army.mil.

The final report will be submitted to Corps headquarters in Washington, D.C. for a decision in February. That timeline could provide for a 2025 construction start.

© 2019 CAPE CODDER
All Rights Reserved.

For reprints or rights, please contact the publisher

CAPE COD TIMES
capecodONLINE.com The Cape and Islands' Daily Newspaper

Date: Saturday, October 05, 2019
Location: HYANNIS, MA
Circulation (DMA): 19,153 (7)
Type (Frequency): Newspaper (D)
Page: 1,4
Section: Main
Keyword: U.S. Army Corps of Engineers

'A MAJOR MILESTONE'

Plan to rebuild canal bridges gets positive reception, although impact on Bourne raises concerns

By Ethan Genter
egenter@capecodonline.com

BOURNE — The Army Corps of Engineers' draft recommendation to build new Bourne and Sagamore bridges was no surprise to most officials on the Cape, but they were heartened to see the federal agency working in concert with the state for what would be a landmark project for the region.

"I'm thumbs-up on the whole thing," said state Rep. Randy Hunt, R-Sandwich. "I just hope we can find the funding to get this thing done."

In a long-awaited report issued Thursday, the Corps recommended building new bridges parallel to the existing ones, envisioning each bridge as six lanes across, with two through lanes and one auxiliary lane in each direction.

The Corps also recommended adding shoulders, a median and a dedicated bicycle and pedestrian lane — all features lacking from the 84-year-old existing bridges.

"It's what we hoped for," said state Sen. Viriato "Vinny" deMacedo, R-Plymouth, who represents towns on both sides of the bridges. "I'm excited."

See BRIDGES, A4

The lane configuration of the bridge that the Corps presented in its draft recommendation is similar to the plan the Massachusetts Department of Transportation put forth in its Cape Cod Canal Transportation Study released earlier this year. The department study looked at making improvements to the roads leading to the bridges.

"I think they did a really good job," Hunt said. "Kudos to everyone involved."

In 2018, representatives of the Corps, which owns and maintains the bridges, came to the Cape to talk about major work planned for the two spans that would result in extended closures. The review of the bridge work quickly turned into a forum for people to air their grievances with the bridges and call for replacements.

In the wake of that meeting arose the Coalition for the Fix, a collection of business officials who advocated for new bridges.

"I believe this is a really good step in the right direction," said Marie Oliva, president and CEO of the Cape Cod Canal Region Chamber of Commerce and co-president of the coalition.

It is promising that the Army Corps and Department of Transportation are on the same page, but the region needs to focus on the coming public comment phase and the future design of the bridges, she said.

"We've had a very good relationship," department Highway Administrator Jonathan Gulliver said.

Both agencies said they have been working closely together and their recommended plans seem to link well.

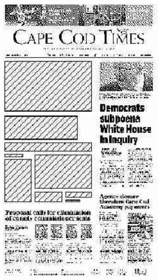
"The two really fit together," said Scott Acone, the Corps' deputy district engineer for programs and project management in the New England District. "Really like two pieces of a puzzle."

The canal bisects Bourne, and the town stands to be most affected by any plans from the state and the Corps. That has left some residents and officials critical of the recommendations by both agencies.

"When (the Corps) begins the design, we want the Corps to work hand-in-hand with us," Oliva said. "We need them to work with us."

She wants the Corps to go beyond the scheduled public meetings and have one-on-one meetings with members of the town.

The bridges have come to the end of their useful life and are far from meeting modern-day road standards. In its initial analysis — which looked at scenarios such as replac-



© 2019 Dow Jones Local Media Group, Inc.
All Rights Reserved.

For reprints or reuse, please e-mail sean.polay@dowjones.com or
send a letter to Sean Polay, Dow Jones Local Media Group, Box 580, Middletown, NY 10940

ing both bridges with a single bridge; the addition of a third automobile bridge not overseen by the Corps; replacement of the bridges with tunnels; and even filling in the canal — the Corps determined that the cost of replacement — about $1 billion — would be more practical than spending about the same for major rehabilitation and that full bridge closures that would be needed to keep the infrastructure up to par.

Although the project's main purpose is to maintain the canal crossings, the Corps did consider the cost of delayed travelers and environmental and social effects.

Acting Bourne Town Administrator Glenn Cannon said he hoped the project could help with the town's traffic woes.

"I definitely think it's a good thing for the town of Bourne," he said.

For residents of Bourne, congested roads have become a year-round headache.

"If we can reduce that congestion, this is a good thing," Cannon said.

But Bourne also will have to absorb the most impact of the major construction project, although the Corps said any traffic disturbances during construction would be minimal.

The Corps has estimated that it would need to acquire 11 acres for the new Bourne Bridge and about 4.5 acres for the Sagamore Bridge. The cost of acquisition, improvements and relocation of businesses was estimated at $7.8 million per bridge.

The Corps could not say exactly where the land would be, noting those decisions would be made in the design phase, after the recommendation was finalized.

"We don't know the specifics," Acone said.

Cannon has not seen nor heard of any plans from the Corps, so the issue remains a sticking point for the town.

"You have to be concerned about it," he said.

For tourists coming to the Cape, the narrow and deteriorating bridges can mean a few more minutes in traffic, but it's a totally different issue for Cape residents, especially those in Bourne, Selectman Judith Froman said.

"It's our everyday life," she said.

Wendy Northcross, CEO of the Cape Cod Chamber of Commerce, has been pushing for a plan from the Corps for 10 years. When she heard the news Thursday night, she said, she felt pure joy and started to scream at the top of her lungs.

"This is just a major milestone that we feel really good about," she said. "I get the sense the community is really ready for this."

Now that the plan is out, the Cape can start to have new conversations, digging into the details about the bridges, she said. She was confident that, even though it will take years, the bridges will be built.

The state Department of Transportation has started initial design work on some of the roads leading to the bridges, but officials from both agencies stressed that nothing is final.

"This is a draft recommendation," said Craig Martin, project manager for the Corps bridge study.

Acone agreed.

"It's really not the end," he said. "We're still in the beginning."

Follow Ethan Genter on Twitter: @EthanGenterCCT.

How to respond to the study

Public comments

The Army Corps of Engineers will accept public comments on the draft study on the Bourne and Sagamore bridges through Nov. 1. Comments may be submitted at the public meetings or online at CapeCodCanalBridgesStudy.com. Written comments may be submitted to U.S. Army Corps of Engineers, New England District, Attn: Craig Martin, 696 Virginia Road, Concord, MA 01742-2751. Comments also may be emailed to nae-pn-nav@usace.army.mil.

Public hearings on Cape

Bourne: 6 p.m. Oct. 16, Bourne High School auditorium, 75 Waterhouse Road

Eastham: 6 p.m. Oct. 22, Nauset Regional High School auditorium, 100 Cable Road

Hyannis: 6 p.m. Oct. 23, Barnstable High School Performing Arts Center, 744 W. Main St.

© 2019 Dow Jones Local Media Group, Inc.
All Rights Reserved.

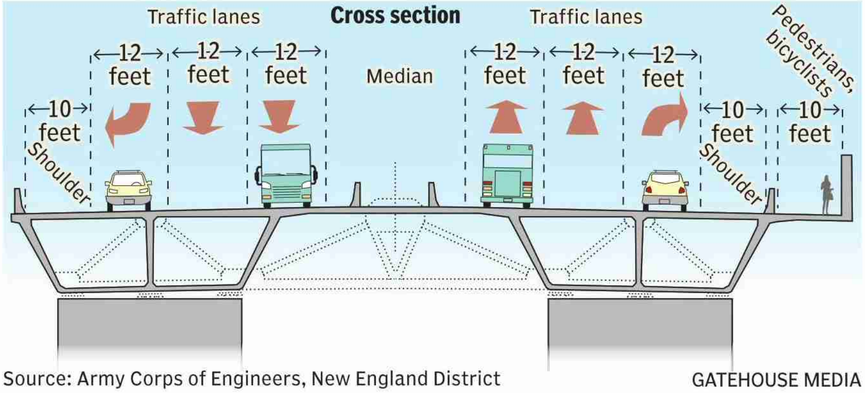
For reprints or reuse, please e-mail sean.polay@dowjones.com or
send a letter to Sean Polay, Dow Jones Local Media Group, Box 580, Middletown, NY 10940

CAPE COD TIMES
capecodONLINE.com The Cape and Islands' Daily Newspaper

Date: Saturday, October 05, 2019
Location: HYANNIS, MA
Circulation (DMA): 19,153 (7)
Type (Frequency): Newspaper (D)
Page: 1,4
Section: Main
Keyword: U.S. Army Corps of Engineers

Proposed bridge layout

An Army Corps of Engineers report recommends wider lanes on two new Cape Cod Canal bridges, with two travel lanes and one entrance/exit lane in each direction, a median, shoulders on either side and a lane for pedestrians and bicyclists.



Source: Army Corps of Engineers, New England District

GATEHOUSE MEDIA

An aerial view shows the Bourne and Sagamore bridges over the Cape Cod Canal. The Army Corps of Engineers, which owns and maintains the bridges, has recommended that they both be replaced. [COURTESY OF ARMY CORPS OF ENGINEERS]

© 2019 Dow Jones Local Media Group, Inc.
All Rights Reserved.

For reprints or reuse, please e-mail sean.polay@dowjones.com or
send a letter to Sean Polay, Dow Jones Local Media Group, Box 580, Middletown, NY 10940

Date: Saturday, October 05, 2019
Location: HYANNIS, MA
Circulation (DMA): 19,153 (7)
Type (Frequency): Newspaper (D)
Page: 1,4
Section: Main
Keyword: U.S. Army Corps of Engineers

Construction on the Bourne Bridge was completed in 1935. The town of Bourne stands to be most affected by any plans by the state and the Army Corps of Engineers for canal bridge replacement and reconfiguration of surrounding roads. The impact could include land-takings and business relocations. [STEVE HEASLIP/ CAPE COD TIMES]

© 2019 Dow Jones Local Media Group, Inc.
All Rights Reserved.

For reprints or reuse, please e-mail sean.polay@dowjones.com or
send a letter to Sean Polay, Dow Jones Local Media Group, Box 580, Middletown, NY 10940

BOSTON Herald

Date: Saturday, October 05, 2019
Location: BOSTON, MA
Circulation (DMA): 72,283 (7)
Type (Frequency): Newspaper (D)
Page: 6
Section: Main
Keyword: U.S. Army Corps of Engineers

CAPE CUTOFF

Corps calls for replacing both bridges over canal

By STEFAN GELLER

Officials should tear down and replace the Bourne and Sagamore bridges that cross the Cape Cod Canal, the U.S. Army Corps of Engineers said Thursday.

"The existing bridges are 85 years old and are functionally obsolete," a report from the Corps read. "The most cost-effective, long-term means of providing vehicular crossing of the Canal is replacement of both bridges with new bridges that conform to modern highway design standards."

The Corps' announcement comes after years of discussion and studies into the costs and benefits of such an endeavor, as well as the safety and reliability of the two bridges.

In the call for their replacement, the Corps said the new bridges would each have six lanes: four travel lanes and two additional auxiliary lanes for acceleration and deceleration. They would also include appropriate access for bicyclists and pedestrians.

The Corps also said that replacing the current bridges would save money that otherwise would be spent making continuous repairs. Both bridges are scheduled to be rehabilitated by the end of 2031, which would cost a combined total of approximately $395 million, according to the Corps.

The two existing bridges would remain in operation until the new bridges are opened to traffic, the Corps said.

The Corps said they still need to determine the final bridge type and detailed design parameters.

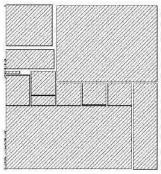
In the meantime, members of the public are encouraged to provide input on the Corps' recommendations, which they will be able to do through Nov. 1. From there, the Corps will finalize plans based on the comments.

In addition to providing feedback through the Corps website, those interested in giving input will be able to attend five public meetings that will be held throughout October on Cape Cod, the South Shore and in Boston.

The final report will be submitted to Corps headquarters in Washington, D.C., for decision in February 2020.

Public meetings on the bridge study are scheduled for:

- Wednesday, Oct. 16 at Bourne High School auditorium, 75 Waterhouse Road, Bourne
- Thursday, Oct. 17, at Plymouth South High School Performing Arts Center, 490 Long Pond Road, Plymouth
- Monday, Oct. 21, at Thomas P. O'Neill Jr. Federal Building auditorium, 10 Causeway St., Boston. Registration and open house at 1 p.m.; Meeting starts at 1:30 p.m.
- Tuesday, Oct. 22, at Nauset Regional High School auditorium, 100 Cable Road, Eastham
- Wednesday, Oct. 23, at Barnstable High School Performing Arts Center, 744 West Main St., Hyannis



© 2019 Boston Herald Inc.
All Rights Reserved.

For Boston Herald licensing/reprint information, please contact 617-619-6680 or email library@bostonherald.com.

MATT STONE / BOSTON HERALD

TROUBLED BRIDGES OVER WATER: Traffic crosses the Bourne, above, and Sagamore, below, briges Friday. The Corps of Engineers, which is responsible for the two lifelines to Cape Cod, says both bridges need to be replaced.

© 2019 Boston Herald Inc.
All Rights Reserved.

For Boston Herald licensing/reprint information, please contact 617-619-6680 or email library@bostonherald.com.

Bourne and Sagamore bridges should be replaced, Army Corps concludes

By Ethan Genter
CAPE COD TIMES

CONCORD – The U.S. Army Corps of Engineers has recommended replacing the aging Bourne and Sagamore bridges – the only land access to Cape Cod – with construction possibly starting in 2025.

The recommendation came in a draft version of the Corps' long-awaited Major Rehabilitation Evaluation Study, which weighed rehabbing the two 84-year-old bridges against replacing them. The Corps, which owns and maintains the bridges, determined that the estimated $1.5 billion to replace them would be more cost-effective than the similar amount it would take to rehabilitate them.

As recommended, each new bridge would have four travel lanes, two in each direction, and an auxiliary lane on both sides. There also are plans for a median, shoulders and a separate bike and pedestrian lane, which the current bridges do not have. The lanes also would be widened from 10 to 12 feet.

The existing bridges would remain open during construction and be demolished after the new bridges are finished. The new Sagamore Bridge would be built to the west of the existing bridge and the new Bourne Bridge to the east of that span.

The construction wouldn't significantly affect traffic, according to the report. But the existing bridges would still need maintenance during that time.

The Corps estimated that it would need to acquire 11 acres for the new Bourne Bridge and about 4.5 acres for the Sagamore Bridge. The cost of acquisition, improvements and relocation of businesses was estimated at $7.8 million per bridge.

The Cape Cod Canal was built in 1916 to cut down on travel times for ships heading south from Boston. The bridges were built about 20 years later, when the Cape's population was about 26,000 people and vehicles were much smaller than the SUVs and trucks that cross the bridges now. The population now exceeds 200,000, and soars to about a half-million in the summer.

BRIDGES/PAGE 5

Both bridges are structurally deficient and do not meet modern-day standards.

"The existing bridges were constructed 84 years ago and require increasingly more frequent repair and maintenance, which is costly and causes significant impact to traffic crossing the Cape Cod Canal," the Army Corps wrote in a statement.

The Corps will begin a public comment period later this month. Public meetings will be held in Bourne, Plymouth, Boston, Eastham and Hyannis.

The Corps will review those comments and then complete its report and give its decision, possibly by spring. That timeline could allow construction to start in 2025.

The final report will be submitted to Corps headquarters in Washington, D.C., for a decision in February. Public comments on the report will be taken through Nov. 1.

"I am pleased to see that the Army Corps of Engineers' report concludes that the best and most cost-effective way to manage the vital transportation link over the Cape Cod Canal is to construct two modern bridges to replace the Bourne and the Sagamore," U.S. Rep. William Keating, D-Mass., said in a statement.

"Two new bridges built up to modern standards will improve traffic flow, allow better access to the Cape and Islands in the coming years, and provide vital evacuation routes. … As a year-round resident of Cape Cod who depends on the Bourne Bridge, I strongly feel that this is the best outcome for our Cape and Islands community and the greater southeastern region as a whole. Our federal delegation stands together in pursuing funding in Congress for this important project."

The state Department of Transportation came to a similar conclusion about the bridges in May. After a five-year study, the state proposed bridges that were 138 feet wide – 90 feet wider than the existing ones. The department envisioned each bridge with six 12-foot lanes, a 10-foot-wide median, a 12-foot-wide shared-use path and a 6-foot

© 2019 PATRIOT LEDGER
All Rights Reserved.

For reprints or rights, please contact the publisher

sidewalk on either side.

The state also recommended revamping several of the roads leading to the bridges. Bonds for that work were proposed in Gov. Charlie Baker's $18 billion bond bill earlier this year.

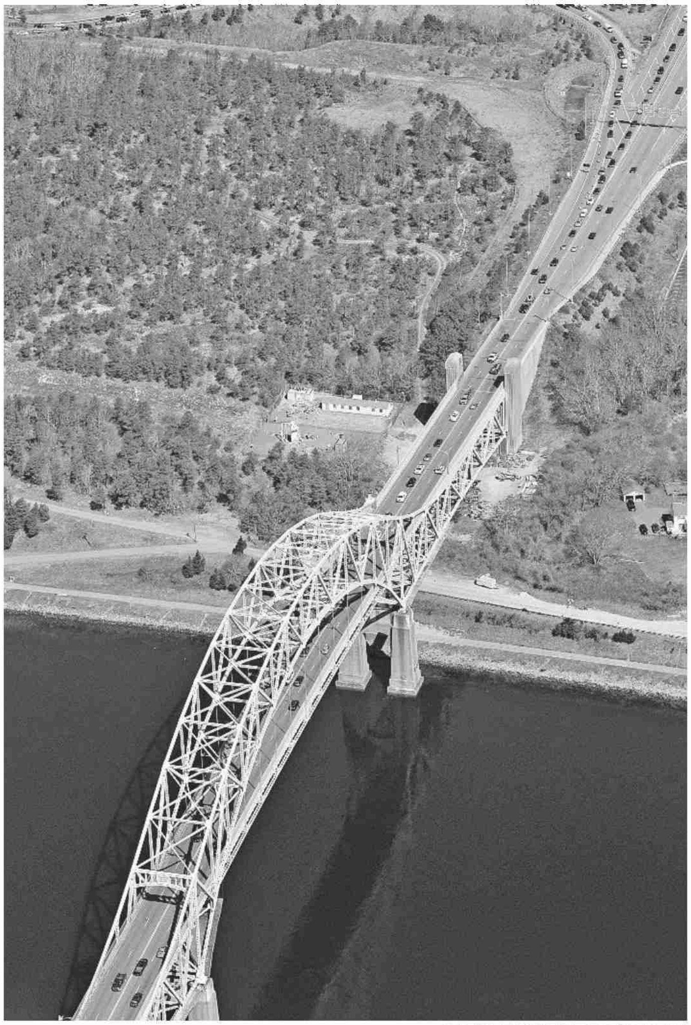
A hearing on that bill is scheduled for Tuesday, Cape Cod Regional Transit Authority Administrator Thomas Cahir said.

Bills before Congress could help pay for the bridges, including a $5 million amendment in an appropriations bill that would pay for their design and a $1 billion bill that would bolster the nation's evacuation routes, which include the bridges.

Rehabilitation of the bridges was estimated to take 3½ years and result in temporary and full closures.

Other scenarios looked at in the Corps report include replacing both bridges with a single bridge; the addition of a third automobile bridge not overseen by the Corps; replacement of the bridges with tunnels; and even filling in the canal.

Both bridges are 84 years old and structurally deficient, and do not meet modern-day standards.



STEVE HEASLIP/CAPE COD TIMES

■ An aerial view of the Sagamore Bridge as traffic congestion increases heading to the Cape. The Army Corps of Engineers, which owns and maintains both vehicular bridges over the canal, has recommended replacing them.

© 2019 PATRIOT LEDGER
All Rights Reserved.

BOURNE ENTERPRISE

Date: Friday, October 18, 2019
Location: FALMOUTH, MA
Circulation (DMA): 8,738 (9)
Type (Frequency): Newspaper (W)
Page: 1,8
Section: Main
Keyword: U.S. Army Corps of Engineers

REPLACEMENT PLAN SPURS CONCERNS

Public Reacts To Proposal To Replace Bourne, Sagamore Bridges

By MICHAEL J. RAUSCH

Universal enthusiasm is not greeting the proposed replacement of the Bourne and Sagamore bridges over the Cape Cod Canal.

A number of Bourne residents have expressed concerns over the Army Corps of Engineers' recommendation that the two spans be replaced. People who live or have businesses within the vicinity of the bridges also have conveyed fears over how construction will impact their property.

The concerns were shared with Army Corps and Massachusetts Department of Transportation officials during a presentation of the Corps's Major Rehabilitation Evaluation Report on Wednesday at Bourne High School. The draft report recommends replacing the two aging spans, as opposed to continuing to keep and repair them.

Army Corps project manager Craig Martin told the audience gathered in the high school auditorium that a number of alternatives, relative to the bridges, were given consideration.

Among the alternatives that the Corps abandoned were: a third bridge in between the current bridges; a tunnel running beneath the Cape Cod Canal; filling in the canal, and a series of low bridges connecting the Cape to the mainland.

All of those alternatives, he said, were considered not viable.

The four alternatives given consideration were: fix-as-fails, which means doing repairs as needed; major rehabilitation of the current bridges as they are currently built; replacement with 4-lane structures; and replacement with 4-lane, plus 2-auxiliary lane bridges. The latter is the Army Corps's chosen recommendation, he said.

"We believe it is the most fiscally and environmentally responsible plan for access on and off the Cape," he said.

The cost to build two new bridges, Mr. Martin said, has been estimated at roughly $1 billion.

Replacing the bridges, instead of continuing to repair them, also was the recommendation of MassDOT's Cape Cod Canal Region Transportation Study Group. The study group issued the results of its five-year study in February.

The draft report recommends new structures that will include four travel lanes and two acceleration/deceleration lanes built to modern highway standards. The bridges would also be built with appropriate bike/pedestrian access.

Former Bourne police officer John Doble was one of several residents who questioned what will happen to their property. Mr. Doble said that his home on Sandwich Road is on the Cape side of the canal and situated directly beneath the Bourne Bridge.

"How much is my property going to be impacted by this construction of the new bridge, and what are the alternatives that we have?" he asked.

Similar statements were made by James Poore of Sagamore and Robert Curtis of Pocasset. Mr. Poore said he lives on Eleanor Avenue, right next door to the bridge, and wondered about the impact of construction over a

see **Replacing Canal Bridges** on Page 8

number years to his property value and his personal well-being.

"A lot of concerns that I'd like to be kept up to date on," he said.

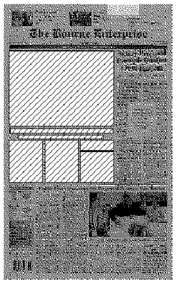
Mr. Curtis was more direct in his comments. He said that he was not aware that bridge replacement could lead to people losing their homes. The prospect of that happening, he said, he found to be shocking.

"The government today is over-reaching," he said, "and you start taking people's homes, I think you're going to find pushback from the old people on Cape Cod."

Mr. Martin assured everyone that the bridge project is currently conceptual only and has not entered the design phase. When it does enter the design phase, Mr. Martin said, residents will be alerted and consulted for their input.

"We're going to be extending our working groups that are going to work with the local abutters to determine the height, size and location of the final bridges," he said.

Several town officials addressed the panel and urged them to make sure that the Town of Bourne "has a seat at the table" when discussions are held on bridge design and construction. Selectmen chairman Judith M. Froman noted that building the bridges "directly impacts our daily municipal operations and



© 2019 BOURNE ENTERPRISE
All Rights Reserved.

lives."

"We request that Army Corps and Mass DOT join with Bourne Board of Selectmen in public sessions to start to work out a public engagement schedule with the various stakeholders locally," she said.

Town Clerk Barry H. Johnson mentioned that he is also the general manager of the Bourne Recreation Authority. The authority is responsible for Gallo Ice Arena and Bourne Scenic Park. Both facilities are situated in close proximity to the Bourne Bridge, Mr. Johnson said.

"The recreation authority is asking the same thing that the town officials are asking," he said, "that we be part and parcel of the overall discussions."

Some residents said they were in favor of a third bridge in between the two current bridges that would have roads connecting to Route 93 and Route 25 off Cape, and Route 6 on the Cape. Others said they supported a series of smaller bridges spanning the canal.

Stephen J. Buckley of Chatham said that whatever decision is made relative to the bridges, equal attention needs to be paid to the Cape's highway system. Mr. Buckley said that wider bridges will mean more traffic coming out to the Cape. The question, he said, is how new bridges will affect the entire region and not just the canal region.

In addition to Wednesday's meeting at Bourne High, other Cape meetings will be held: on Thursday, October 17, at Plymouth South High School Performing Arts Center; Tuesday, October 22, at Nauset Regional High School in Eastham; and Wednesday, October 23, at the Barnstable High School Performing Arts Center in Hyannis. Those meetings also begin at 6 PM.

An off-Cape meeting is scheduled for Monday, October 21, at 1 PM, at the Thomas P. O'Neill Jr. Federal Building on Causeway Street in Boston.

The Corps said it will accept public comments on the recommendations in the study through Friday, November 1.

At the end of the public comment period, the Corps will address issues raised by the public. In addition to public comment, the draft report will also undergo an independent external peer review by members of the private and academic sectors, the Corps said.

A final recommendation on whether to replace or continue to repair the Cape Cod Canal bridges will be contained in the final report that will be submitted to Corps headquarters in Washington, DC, in February 2020.

© 2019 BOURNE ENTERPRISE
All Rights Reserved.

GENE M. MARCHAND/ENTERPRISE

The Army Corp of Engineers holds a presentation at Bourne High School Wednesday night detailing the plans for replacing the Bourne and Sagamore bridges. The presentation was followed by an open question and comment period.

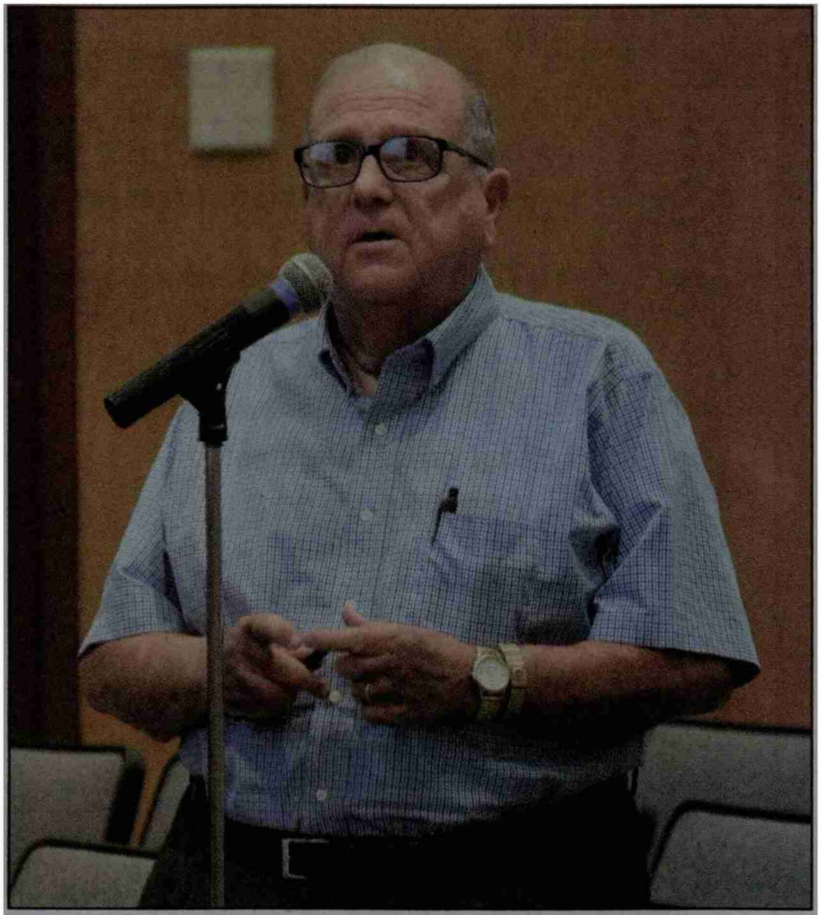
© 2019 BOURNE ENTERPRISE
All Rights Reserved.

GENE M. MARCHAND/ENTERPRISE

Bourne selectmen chair Judith Froman, chairman of the board of selectmen, comments at the meeting.

© 2019 BOURNE ENTERPRISE
All Rights Reserved.

For reprints or rights, please contact the publisher



GENE M. MARCHAND/ENTERPRISE

Bourne Town Clerk Barry Johnson urges involving entities directly affected by the proposal in the planning.

© 2019 BOURNE ENTERPRISE
All Rights Reserved.

OLD COLONY MEMORIAL

Date: Wednesday, October 23, 2019
Location: PLYMOUTH, MA
Circulation (DMA): 4,453 (9)
Type (Frequency): Newspaper (2WK)
Page: A10
Section: Main
Keyword: U.S. Army Corps of Engineers

Reviewing plans for the spans

Army Corps of Engineers gets Plymouth input on replacing canal bridges

By **David Kindy**
dkindy@wickedlocal.com

PLYMOUTH - What would happen if and when two new bridges are built over the Cape Cod Canal? Plymouth residents were asking that question at a public meeting last week with the Army Corps of Engineers, which is responsible for constructing the new spans.

Approximately 25 people attended the session on Thursday to find out what they can expect from this major project estimated at more than $1 billion, which could begin as early as 2025. Eight people asked questions and made statements about the future project. One person had concerns about how his house and business would be impacted if the bridges are replaced.

"Undoubtedly, it will have an impact on local neighborhoods but the full extent is not known yet.

According to Tim Dugan of the New England District of the Corps of Engineers, that's because there are still a lot of variables to be decided.

"We are preparing a draft study with an initial recommendation to replace the bridges," he said. "The report has to be completed, go through technical reviews and approved at Corps headquarters in 2020 before we seek funding. All that has to happen before we even start thinking about planning and design - if approved. That is a long way off."

The Corps of Engineers announced earlier this month it was recommending replacing both the Sagamore and Bourne bridges, which were built nearly 85 years ago. Both require extensive work to maintain and have reached the point where structural integrity is becoming an issue.

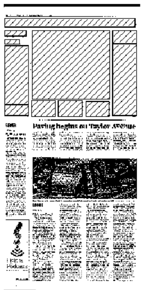
The current plan calls for constructing two new bridges with four full-size travel lanes and two additional auxiliary lanes for acceleration and deceleration – all built to modern highway standards and with bicycle and pedestrian access. The work could take up to three years to complete. The current bridges would remain in use until the new spans are completed.

Funding for the new bridges would come from the federal government. Sens. Edward Markey and Elizabeth Warren and U.S. Rep. William Keating are urging the Corps of Engineers to include all necessary funding in its Work Plan for Fiscal Year 2020.

The Sagamore and Bourne bridges, which connect nearly 250,000 residents on Cape Cod, Martha's Vineyard and Nantucket to the rest of Massachusetts, are vital to the regional and state tourism economies.

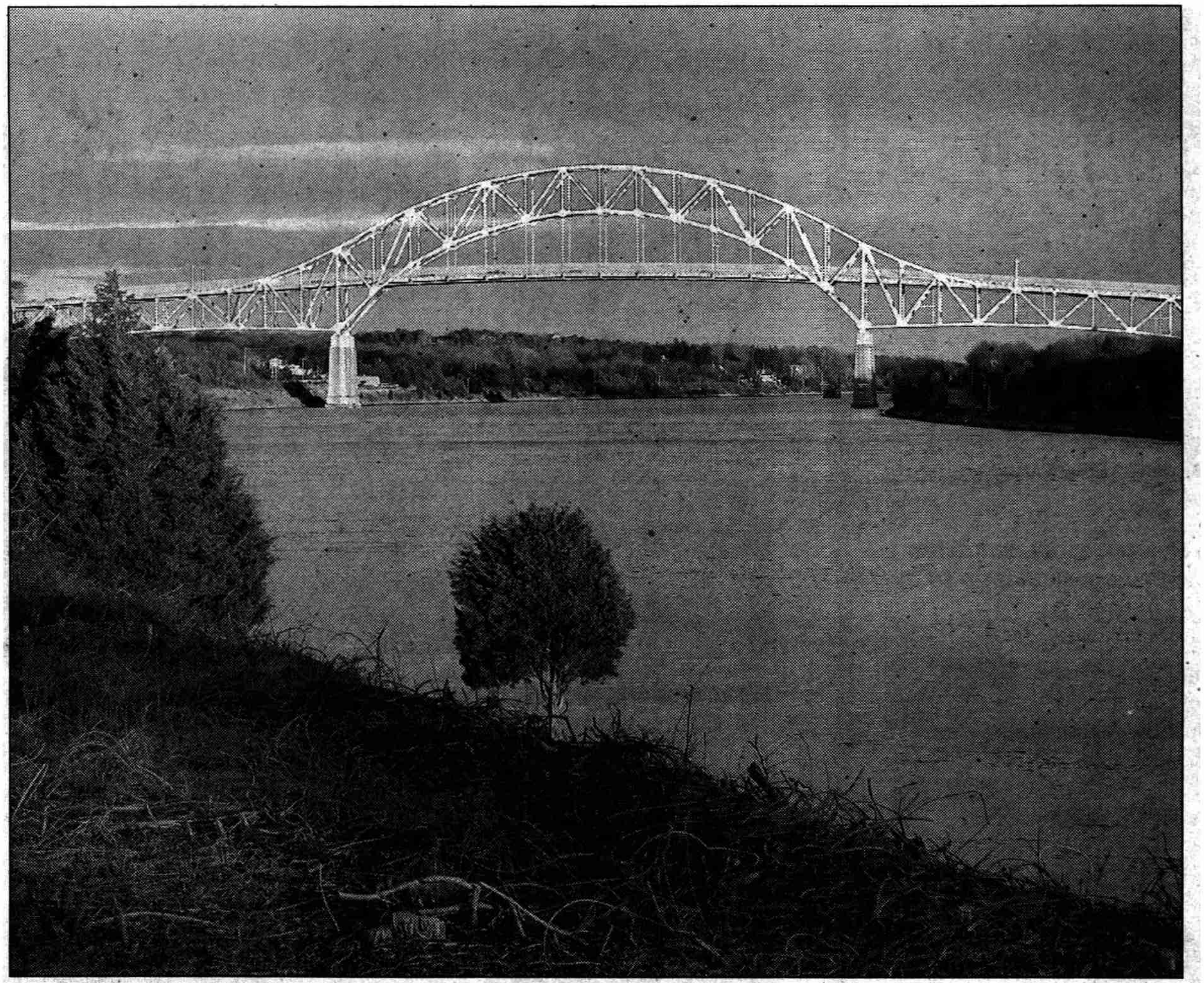
At the Plymouth meeting, the Corps of Engineers presented the draft Major Rehabilitation Evaluation Report and environmental assessment for review by the public, which can present comments for consideration. The report will also undergo an independent external peer review by the private and academia sectors before a final recommendation on whether to replace or continue to repair the Cape Cod Canal bridges is submitted to Corps headquarters in Washington, D.C. for decision in February 2020.

The Corps of Engineers will accept public comments on the draft study through Nov. 1. They can be submitted online at www.CapeCodCanalBridgesStudy.com. Written comments can be sent to: U.S. Army Corps of Engineers, New England District, (Attn: Craig Martin), 696 Virginia Road, Concord, MA 01742-2751. Comments also can be emailed to nae-pn-nav@usace.army.mil.



© 2019 OLD COLONY MEMORIAL
All Rights Reserved.

For reprints or rights, please contact the publisher



The U.S. Army Corps of Engineers is recommending replacing the Sagamore (shown) and Bourne bridges across Cape Cod Canal. [COURTESY PHOTO/U.S. ARMY CORPS OF ENGINEERS]

© 2019 OLD COLONY MEMORIAL
All Rights Reserved.

CAPE COD TIMES
capecodONLINE.com

Date: Friday, November 01, 2019
Location: HYANNIS, MA
Circulation (DMA): 19,153 (9)
Type (Frequency): Newspaper (D)
Page: 2
Section: Main
Keyword: U.S. Army Corps of Engineers

More time allotted for comment on bridge study

Army Corps now accepting public feedback until Nov. 15

Online

Read more about plans for the bridges: **capecodtimes.com.**

By Ethan Genter
egenter@capecodonline.com

CONCORD — The U.S. Army Corps of Engineers has extended the public comment period on its draft study that gives a preliminary recommendation to replace the Bourne and Sagamore bridges, the federal agency announced Thursday.

Public comment on the study was supposed to end Nov. 1, but the Corps decided to extend it for two weeks to Nov. 15, according to a statement.

"We felt that since this is important to the future of Cape Cod and the region, we could afford to provide more time for the public to submit comments on the Corps recommendation in the MRER study," Corps spokesman Timothy Dugan said. "We did receive one request to extend the comment period."

In the study, released in early October, the Corps recommended replacing the two 84-year-old bridges with new, wider spans. It recommended six-lane bridges with four through lanes and two auxiliary lanes, along with shoulders, a median and a pedestrian and bicycle lane.

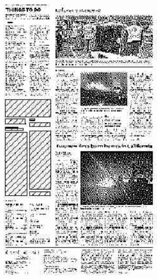
The goal of the study was to decide whether the Corps should continue to rehabilitate the bridges or build new ones. The agency has been holding public comment sessions on the plans both on-Cape and off.

Those comments will be considered before the Corps finalizes its report in February. A decision on whether to replace the bridges is expected in the spring.

The study can be found online at capecodcanalbridgesstudy.com.

Public comments can be submitted online at that website, and written comments can be submitted to U.S. Army Corps of Engineers, New England District, (Attn: Craig Martin), 696 Virginia Road, Concord, MA 01742-2751. Comments also can be emailed to nae-pn-nav@usace.army.mil.

Follow Ethan Genter on Twitter: @EthanGenterCCT.



© 2019 Dow Jones Local Media Group, Inc.
All Rights Reserved.

For reprints or reuse, please e-mail sean.polay@dowjones.com or
send a letter to Sean Polay, Dow Jones Local Media Group, Box 580, Middletown, NY 10940

CAPE COD TIMES
capecodONLINE.com The Cape and Islands' Daily Newspaper

Date: Saturday, November 16, 2019
Location: HYANNIS, MA
Circulation (DMA): 19,153 (9)
Type (Frequency): Newspaper (D)
Page: 10
Section: Main
Keyword: U.S. Army Corps of Engineers

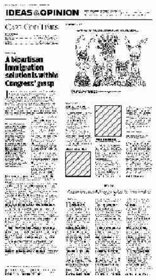
Once third bridge crosses canal, where will all that traffic go?

I write in response to Tom Baron's Nov. 5 letter, "Without plans for a third bridge, canal transit changes are doomed."

Having a third bridge is not the answer to the canal crossings problem. Where will the traffic go after the bridge is crossed? As long as we have a two-lane Route 6 on the Cape, the congestion will continue. The only viable solution is to have the two new bridges built as planned by the Army Corps of Engineers with a moveable barrier allowing for three lanes going on-Cape on Friday and three lanes going off-Cape on Sunday – and at the same time, widen Route 6 to three lanes in each direction all the way to Exit 9.

As long as there are only two lanes in each direction on Route 6, the traffic snarls will continue.

Richard Susskind, Sandwich



© 2019 Dow Jones Local Media Group, Inc.
All Rights Reserved.

For reprints or reuse, please e-mail sean.polay@dowjones.com or
send a letter to Sean Polay, Dow Jones Local Media Group, Box 580, Middletown, NY 10940

Pembroke Mariner

Date: Friday, October 11, 2019
Location: MARSHFIELD, MA
Circulation (DMA): 1,140 (9)
Type (Frequency): Newspaper (W)
Page: A1,A4
Section: Main
Keyword: U.S. Army Corps of Engineers

Friendly political rivals share successes

Area legislators talk about efforts to improve, promote the region

By David Kindy
dkindy@wickedlocal.com

What do you get when you take a bunch of politicians from both parties and throw them in a room together? Mutual respect and good-natured kidding.

That was the case at the 2019 Legislative Breakfast, presented Friday by the Plymouth Area Chamber of Commerce at the Hotel 1620 Plymouth Harbor. Instead of rancorous debate and name-calling, local politicians joked with each other and related how they work together to solve problems at the State House and in the district.

"Even though we come from

See RIVALS, A4

different backgrounds, we're all friends," said state Sen. Vinny deMacedo. "We don't take it personally. We maintain decorum and agree to disagree."

The spirit of congeniality was evident throughout the Legislative Breakfast as each speaker – Democrat or Republican – supported their colleagues on a myriad of issues concerning local communities: economic development, gambling, transportation, tourism and more.

DeMacedo, R-Plymouth, led off the session by discussing how the Massachusetts Legislature has been working to increase funding for the Rainy Day Fund. The stabilization account has grown substantially in less than five years, from $1.8 billion in 2015 to $2.6 billion today. It is expected to reach $3.5 billion by 2020. The fund helps the state pay for important programs when tax revenues fall during economic decline, and a strong fund helps make for a strong financial rating.

"We have to be prepared," he said. "When things get bad, that's when you need the Rainy Day Fund. We're in a much better position now than we've ever been."

The racetrack and gambling proposal announced for Wareham was discussed by state Rep. Susan Williams Gifford, R-Wareham. She has filed legislation to have the Massachusetts Gaming Commission review the plans and determine its viability for Region C, which includes Southeastern Massachusetts.

"We want to know if the state can support another casino," she said. "Having this proposal reviewed by the commission will help us understand what we can sustain. This is the first step."

The impact of replacing the Sagamore and Bourne bridges over the Cape Cod Canal was discussed by state Rep. Randy Hunt, R-Sandwich. On Thursday, the U.S. Army Corps of Engineers announced new bridges were necessary and it hoped to begin construction as early as 2025. He detailed the planned improvements, which include wider and additional lanes.

"These changes will help a lot," he said. "Traffic will move much more quickly, which will provide a lot of relief." He added, "Ten years from now, we could be using two new spans."

State Rep. Matt Muratore, R-Plymouth, talked about the "significant dollars" that have gone into infrastructure improvements to help Plymouth prepare for its 400th anniversary in 2020. He said the federal and state delegation worked together to secure $14 million for dredging Plymouth Harbor so larger cruise ships and other vessels can visit.

"The eyes of the country and the world will be on us," he said. "The focus will be on us all year and beyond 2020."

The challenge of dealing with the opioid crisis was the focus of Plymouth County District Attorney Tim Cruz' talk. Cruz, a Republican from Marshfield, described how the Plymouth County Drug Task Force has become a national model by working to reduce opioid deaths while getting referrals for addiction therapy are going up.

"Things are happening here," he said. "We've made a lot of progress, but there's still more we need to do with your help."

State Rep. Josh Cutler, D-Duxbury, discussed his role as a leader of the Workability Taskforce to study the critical issue of workforce development for persons with disabilities.

State Rep, Kathy LaNatra, D-Kingston, discussed a petition to the Office of Business Development to establish a MassMade program to identify, connect and support businesses that produce consumer goods in the commonwealth.

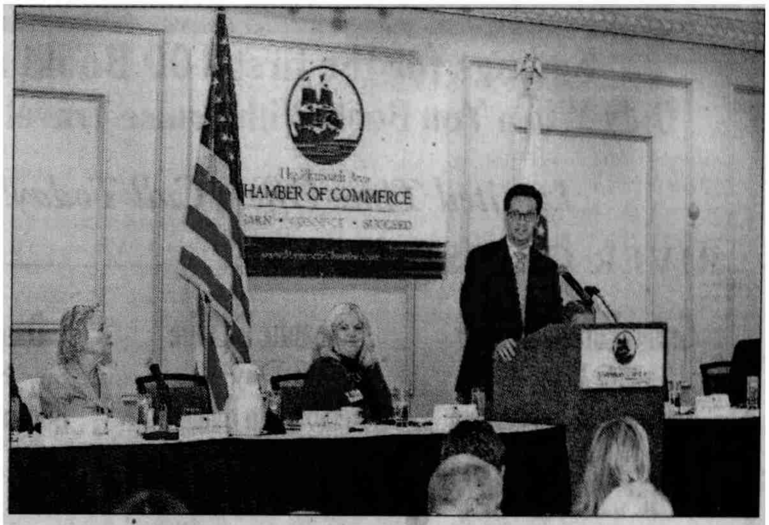
Register of Deeds John

© 2019 PEMBROKE MARINER & EXPRESS
All Rights Reserved.

For reprints or rights, please contact the publisher

Buckley, D-Brockton, provided an update on the Registry's continuing efforts to enable the system to search land records back to 1686.

Plymouth County Sheriff John McDonald, R-Kingston informed the audience of a five-year deal with county commissioners to lease the County Farm land and continue it for agricultural and prisoner work programs.



State Sen. Vinny deMacedo presents the state's healthy fiscal position.
[WICKED LOCAL PHOTO/DENISE MACCAFERRI]

© 2019 PEMBROKE MARINER & EXPRESS
All Rights Reserved.

Pembroke Mariner
Date: Friday, October 11, 2019
Location: MARSHFIELD, MA
Circulation (DMA): 1,140 (9)
Type (Frequency): Newspaper (W)
Page: A1,A4
Section: Main
Keyword: U.S. Army Corps of Engineers

State Rep. Josh Cutler talked about his role as leader of the Workability Taskforce to study the critical issue of workforce development for persons with disabilities. [WICKED LOCAL PHOTO/DENISE MACCAFERRI]

Sharon Brown, PACC Government Affairs Committee chair, welcomes the crowd and state and local legislators to the Plymouth Area Chamber of Commerce annual Legislative Breakfast held last Friday at Hotel 1620. [WICKED LOCAL PHOTO/DENISE MACCAFERRI]

© 2019 PEMBROKE MARINER & EXPRESS
All Rights Reserved.

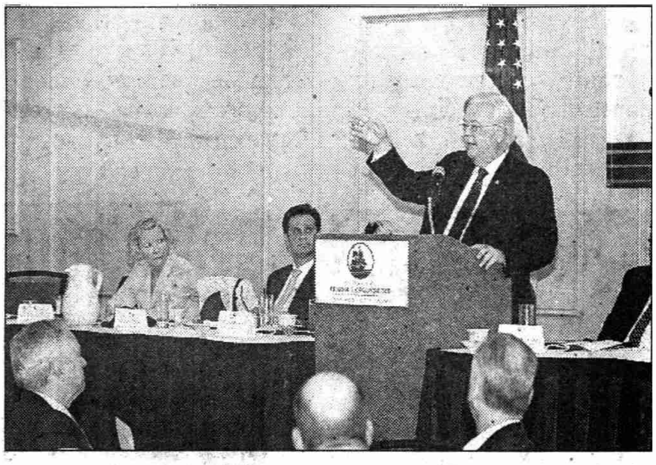
For reprints or rights, please contact the publisher

During the Q&A session of the Legislative Breakfast, PACC Board President Peter Brown asks the panel why bipartisanship works so well locally but not in Washington. The consensus of the panel was mutual respect, not taking things personally, and working together for the greater good of Plymouth and surrounding communities. [WICKED LOCAL PHOTO/DENISE MACCAFERRI]

State Rep. Matt Muratore updates the soon to be Plymouth 400th Anniversary events and the benefits to area businesses during and after 2020. [WICKED LOCAL PHOTO/DENISE MACCAFERRI]

© 2019 PEMBROKE MARINER & EXPRESS
All Rights Reserved.

Pembroke Mariner
Date: Friday, October 11, 2019
Location: MARSHFIELD, MA
Circulation (DMA): 1,140 (9)
Type (Frequency): Newspaper (W)
Page: A1,A4
Section: Main
Keyword: U.S. Army Corps of Engineers



State Rep. Randy Hunt gives some details on the recent news of the Army Corps of Engineers proposal to replace the Sagamore and Bourne bridges. [WICKED LOCAL PHOTO/DENISE MACCAFERRI]

© 2019 PEMBROKE MARINER & EXPRESS
All Rights Reserved.

CAPE COD TIMES
capecodONLINE.com The Cape and Islands' Daily Newspaper

Date: Friday, October 25, 2019
Location: HYANNIS, MA
Circulation (DMA): 19,153 (9)
Type (Frequency): Newspaper (D)
Page: 2
Section: Main
Keyword: U.S. Army Corps of Engineers

Prospect of new canal bridges draws positive reviews

Residents at hearings in Hyannis, Eastham voice enthusiasm for replacement spans

By Ethan Genter
egenter@capecodonline.com

After getting an earful of comments on how the replacement of the Bourne and Sagamore bridges would affect residents of Bourne last week, the U.S. Army Corps of Engineers this week made two additional stops farther down the Cape.

The Corps, which manages and operates the Cape Cod Canal, the two automobile bridges and the railroad bridge, recently issued a draft report that recommended replacement of the Bourne and Sagamore bridges. The federal agency has held meetings to get public input before finalizing its recommendation.

Most who attended the local meetings were in support of replacement.

"It's something that everybody has known for quite a while, that the existing bridges are not sufficient," John Wood, a retiree, said at Wednesday's meeting at Barnstable High School in Hyannis. "An 85-year-old bridge cannot be fixed. I'm not 85 yet, but I know what it is to get old, and bridges do the same thing. Something new is needed, and I'm glad to see that there is agreement with the Corps and all the technical people."

Doug Hempel, past president of the Cape Cod Cycling Club, also was in favor of the Corps' draft plan.

"As somebody who travels across that bridge twice a day every day during the week, I just applaud this effort and hope that it moves forward as quickly as possible," he said.

"Seriously, if you can find the keys to Marty's DeLorean and go back a couple years and start then that would be great," Hempel added, referring to the movie "Back to the Future."

Hempel also was in favor of the dedicated bike and pedestrian lanes that the Corps is recommending for the new bridges.

"Thank you, and start tomorrow," he said.

Stephen Buckley, a Chatham resident who attended all of the Cape meetings as well as one held in Plymouth, used to work in Washington, D.C., reviewing environmental assessments. He has been concerned with the extra amount of traffic that could come to the Cape, should the Corps build the bigger, wider bridges.

"The study makes a statement that there will be no substantial increase in the number of visitors from these bridges," he said at Tuesday's meeting at Nauset Regional High School in North Eastham. "It makes a statement but provides no data or analysis to back that up. From what I can tell it's made out of thin air."

The Lower Cape meeting saw fewer comments, but Eastham Select Board Chairwoman Aimee Eckman asked the Corps to keep the area in the loop.

"I appreciate you coming out tonight. Even though we are far from the bridges, comparatively to the study area, it affects all of us," she said. "I hope you continue to have meetings out here so that we can be involved. It exciting to see something happening."

Follow Ethan Genter on Twitter: @EthanGenterCCT.

Online

Read more about the plans for the Cape bridges: **capecodtimes.com**

At public meetings in Eastham and Hyannis this week, many Cape residents approved of the Army Corps of Engineers' recommendation to build two new structures to replacing the aging Sagamore and Bourne bridges. [MERRILLY CASSIDY/CAPE COD TIMES FILE]

© 2019 Dow Jones Local Media Group, Inc.
All Rights Reserved.

Account: 31366 (20209)
MA-117
For reprints or reuse, please e-mail sean.polay@dowjones.com or
send a letter to Sean Polay, Dow Jones Local Media Group, Box 580, Middletown, NY 10940

Carver Reporter

Date: Friday, October 11, 2019
Location: PLYMOUTH, MA
Circulation (DMA): 1,916 (9)
Type (Frequency): Newspaper (W)
Page: 5
Section: Main
Keyword: U.S. Army Corps of Engineers

Friendly political rivals share successes

Area legislators talk about efforts to help Plymouth and beyond

By David Kindy
dkindy@wickedlocal.com

What do you get when you take a bunch of politicians from both parties and throw them in a room together? Mutual respect and good-natured kidding.

That was the case at the 2019 Legislative Breakfast, presented last Friday by the Plymouth Area Chamber of Commerce at the Hotel 1620 Plymouth Harbor. Instead of rancorous debate and name-calling, local politicians joked with each other and related how they work together to solve problems at the State House and in the district.

"Even though we come from different backgrounds, we're all friends," said state Sen. Vinny deMacedo. "We don't take it personally. We maintain decorum and agree to disagree."

The spirit of congeniality was evident throughout the Legislative Breakfast as each speaker – Democrat or Republican – supported their colleagues on a myriad of issues concerning local communities: economic development, gambling, transportation, tourism and more.

DeMacedo, R-Plymouth, led off the session by discussing how the Massachusetts Legislature has been working to increase funding for the Rainy Day Fund. The stabilization account has grown substantially in less than five years, from $1.8 billion in 2015 to $2.6 billion today. It is expected to reach $3.5 billion by 2020. The fund helps the state pay for important programs when tax revenues fall during economic decline, and a strong fund helps make for a strong financial rating.

"We have to be prepared," he said. "When things get bad, that's when you need the Rainy Day Fund. We're in a much better position now than we've ever been."

The racetrack and gambling proposal announced for Wareham was discussed by state Rep. Susan Williams Gifford, R-Wareham. She has filed legislation to have the Massachusetts Gaming Commission review the plans and determine its viability for Region C, which includes Southeastern Massachusetts.

"We want to know if the state can support another casino," she said. "Having this proposal reviewed by the commission will help us understand what we can sustain. This is the first step."

The impact of replacing the Sagamore and Bourne bridges over the Cape Cod Canal was discussed by state Rep. Randy Hunt, R-Sandwich. On Thursday, the U.S. Army Corps of Engineers announced new bridges were necessary and it hoped to begin construction as early as 2025. He detailed the planned improvements, which include wider and additional lanes.

"These changes will help a lot," he said. "Traffic will move much more quickly, which will provide a lot of relief." He added, "Ten years from now, we could be using two new spans."

State Rep. Matt Muratore, R-Plymouth, talked about the "significant dollars" that have gone into infrastructure improvements to help Plymouth prepare for its 400th anniversary in 2020. He said the federal and state delegation worked together to secure $14 million for dredging Plymouth Harbor so larger cruise ships and other vessels can visit.

"The eyes of the country and the world will be on us," he said. "The focus will be on us all year and beyond 2020."

The challenge of dealing with the opioid crisis was the focus of Plymouth County District Attorney Tim Cruz' talk. Cruz, a Republican from Marshfield, described how the Plymouth County Drug Task Force has become a national model by working to reduce opioid deaths while getting referrals for addiction therapy are going up.

"Things are happening here," he said. "We've made a lot of progress, but there's still more we need to do with your help."

State Rep. Josh Cutler, D-Duxbury, discussed his role as a leader of the Workability Taskforce to study the critical issue of workforce development for persons with disabilities.

State Rep. Kathy LaNatra, D-Kingston, discussed a petition to the Office of Business Development to establish a MassMade program to identify, connect and support businesses that produce consumer goods in the commonwealth.

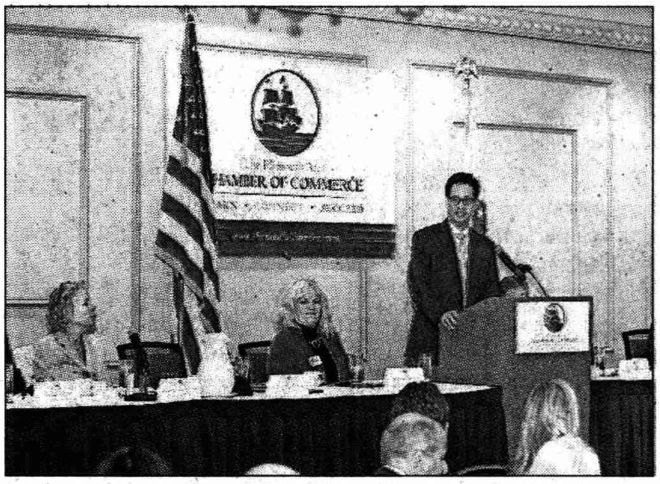
Register of Deeds John Buckley, D-Brockton, provided an update on the Registry's continuing efforts to enable the system to search land records back to

© 2019 CARVER REPORTER
All Rights Reserved.

For reprints or rights, please contact the publisher

1686.

Plymouth County Sheriff John McDonald, R-Kingston informed the audience of a five-year deal with county commissioners to lease the County Farm land and continue it for agricultural and prisoner work programs.



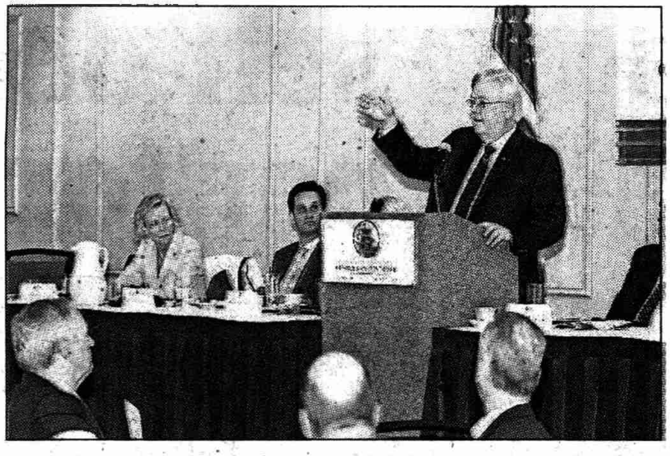
State Sen. Vinny deMacedo presents the state's healthy fiscal position. [WICKED LOCAL PHOTO/DENISE MACCAFERRI]

State Rep. Susan Williams Gifford spoke about a proposal for a thoroughbred race track and gambling in Wareham. [WICKED LOCAL PHOTO/DENISE MACCAFERRI]

© 2019 CARVER REPORTER
All Rights Reserved.

Carver Reporter

Date: Friday, October 11, 2019
Location: PLYMOUTH, MA
Circulation (DMA): 1,916 (9)
Type (Frequency): Newspaper (W)
Page: 5
Section: Main
Keyword: U.S. Army Corps of Engineers



State Rep. Randy Hunt gives some details on the recent news of the Army Corps of Engineers proposal to replace the Sagamore and Bourne bridges. [WICKED LOCAL PHOTO/DENISE MACCAFERRI]

© 2019 CARVER REPORTER
All Rights Reserved.

The Patriot Ledger
Date: Friday, October 25, 2019
Location: QUINCY, MA
Circulation (DMA): 12,223 (9)
Type (Frequency): Newspaper (D)
Page: 1
Section: Main
Keyword: U.S. Army Corps of Engineers

STATE

ARMY CORPS COMMITS TO REPLACING BRIDGES TO CAPE COD

The highest-ranking official in the U.S. Army Corps of Engineers said Wednesday he is committed to replacing the Bourne and Sagamore bridges, but it may take some innovative ideas to get it done.

PAGE 3

© 2019 PATRIOT LEDGER
All Rights Reserved.

For reprints or rights, please contact the publisher

The Patriot Ledger

Date: Thursday, October 17, 2019
Location: QUINCY, MA
Circulation (DMA): 12,223 (9)
Type (Frequency): Newspaper (D)
Page: 4
Section: Main
Keyword: U.S. Army Corps of Engineers

Extend rail lines to Cape over new bridges

Thanks to the Army Corps of Engineers in their efforts to create a new set of bridges over the Cape Cod Canal that would bring those sections of roadway into the 21st century. Wouldn't it also make sense to include in the design a railway track similar to the Longfellow Bridge that connects Cambridge to Boston?

The new Bourne Bridge could incorporate existing rail lines to extend the MBTA Middleboro train service into North Falmouth. On the Sagamore Bridge the MBTA Kingston line could be extended along Route 3 over the canal continuing down Route 6 to the Lorenzo Sand and Gravel site in Hyannis or possibly on to Orleans.

Widening the roadways onto the Cape is a wonderful idea. However, the roadways on the Cape are equally as antiquated as the bridge roadways and far outstrip the capacity to hold the present number of cars even during the offseason. Alternative means of transportation that cut the amount of cars on the road would be a welcome and needed solution.

BILL SULLIVAN
Cotuit

© 2019 PATRIOT LEDGER
All Rights Reserved.

For reprints or rights, please contact the publisher

CAPE COD TIMES
capecodONLINE.com The Cape and Islands' Daily Newspaper

Date: Wednesday, October 30, 2019
Location: HYANNIS, MA
Circulation (DMA): 19,153 (9)
Type (Frequency): Newspaper (D)
Page: 7
Section: Main
Keyword: U.S. Army Corps of Engineers

MY VIEW

New bridges are pivotal to health of Cape economy

By Lisa Oliver

The Army Corps of Engineers has come to the conclusion that new bridges are necessary for the future of Cape Cod. And while there will be much public debate over this decision during the coming weeks, I see the merits of the bridges from three perspectives – as an employer, a banker and a resident.

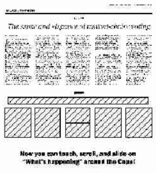
We have more than 165 employees at The Cooperative Bank of Cape Cod. Most of those employees live on the Cape. However, new bridges and easier access to and from the Cape will mean we can attract more talent to the Cape, not just to The Coop, but to all local industries. A larger talent pool will result in a stronger workforce on the Cape. And our pool of employees who do currently commute to the Cape from Plymouth, the South Shore and even Boston pay a significant price in the form of accumulated hours sitting in traffic at the bridges – most notably in lost time with family. For those who need to cross the bridge daily just to get to work, this decision will mean more than just a daily convenience. It means a huge improvement in their quality of life.

As a banker, I'm engaged in an ongoing dialogue with our small-business clients – about their challenges, successes and evolving needs. They're both the front line and the backbone of our economy, and visitors are their bread and butter. This past summer was a particularly challenging one for many businesses as a result of several factors, including weather, new taxes and – yes – bridge traffic. More ease of access to the Cape for visitors means more money being pumped into our small businesses. That's good for all of us who live here. As the saying goes, a rising tide lifts all boats.

As a resident, I welcome the safety that new bridges will bring all of us. Few will contest the argument that the bridges are unsafe and the narrow lanes can be harrowing. Modern bridges with wider lanes, a median, bike path and pedestrian lane will mean fewer accidents and more peace of mind. And in the event of a medical issue or natural disaster, we need to know we can get off-Cape reliably with our loved ones.

There's no doubt that the replacement of the bridges is an economic and safety necessity. This is a pivotal modernization to our infrastructure and in the long run will keep the Cape the vibrant community that it now is.

Lisa Oliver of Barnstable is president and CEO of The Cooperative Bank of Cape Cod.

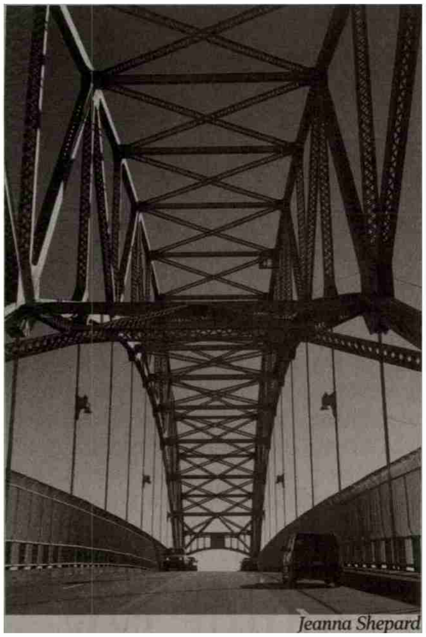


© 2019 Dow Jones Local Media Group, Inc.
All Rights Reserved.

For reprints or reuse, please e-mail sean.polay@dowjones.com or
send a letter to Sean Polay, Dow Jones Local Media Group, Box 580, Middletown, NY 10940

VINEYARD GAZETTE

Date: Friday, October 11, 2019
Location: EDGARTOWN, MA
Circulation (DMA): 8,500 (9)
Type (Frequency): Newspaper (W)
Page: 2
Section: Main
Keyword: U.S. Army Corps of Engineers



Jeanna Shepard

Replacement of Cape Cod Bridges Recommended

A draft report released this week by the U.S. Army Corps of Engineers is recommending replacement of both the Bourne and Sagamore bridges.

The replacement project would cost $1 billion and is the preferred alternative to continuing to repair the bridges, which were built 84 years ago and are functionally obsolete, the draft evaluation by the Corps has found.

The two bridges span the Cape Cod Canal and provide access to Cape Cod, including the ferry ports to the two Islands in Woods Hole and Hyannis.

A series of public meetings have been scheduled by the New England District for the Corps this month on the Cape, in Plymouth and Boston. The first meeting will be held in Bourne on Oct. 16.

The Corps is inviting public comment on the draft report and assessment on its wesbite through Nov. 1.

A final report is expected in February 2020.

© 2019 VINEYARD GAZETTE
All Rights Reserved.

For reprints or rights, please contact the publisher

CAPE COD TIMES
capecodONLINE.com The Cape and Islands' Daily Newspaper

Date: Tuesday, November 05, 2019
Location: HYANNIS, MA
Circulation (DMA): 19,153 (9)
Type (Frequency): Newspaper (D)
Page: 7
Section: Main
Keyword: U.S. Army Corps of Engineers

Coins honoring canal bridges could help pay for replacements

We have all known that the Cape Cod Canal bridges have needed to be replaced for a long time. Now we finally have a cost estimate of over $1 billion to replace both the Sagamore and Bourne bridges.

The head of the Army Corps of Engineers agrees the bridges need to be replaced, but budget constraints will require us to find creative financing.

I suggest we have the U.S. mint mint coins and precious metals with the image of the Cape and the Sagamore and Bourne bridges on one side and an image of the Cape and the new bridges on the reverse side. We could advertise near both bridges and sell them locally. All coin holders would also be exempt from any future tolls on either bridge. And sales would go to funding for the bridges.

Also, some of the steel taken down from the bridges could be melted down and sold as medallions, with the proceeds going to the cost of building the bridges.

I also wonder if the value of the steel on the Bourne and Sagamore bridges has been factored into the cost. That is No. 1, Grade A USA steel that was used to build battleships with; it has an extremely high value and should not just be given away!

The legacy of those who built the bridges needs to be honored. I'm proud to say my grandfather was one.

William C. Rogers
Onset

© 2019 Dow Jones Local Media Group, Inc.
All Rights Reserved.

For reprints or reuse, please e-mail sean.polay@dowjones.com or
send a letter to Sean Polay, Dow Jones Local Media Group, Box 580, Middletown, NY 10940

CAPE COD TIMES
capecodONLINE.com The Cape and Islands' Daily Newspaper

Date: Friday, October 18, 2019
Location: HYANNIS, MA
Circulation (DMA): 19,153 (9)
Type (Frequency): Newspaper (D)
Page: 1,4
Section: Main
Keyword: U.S. Army Corps of Engineers

Army Corps considers turning bridges over to state

If new spans are constructed, divestment could follow

By Ethan Genter
egenter@capecodonline.com

WASHINGTON — The U.S. Army Corps of Engineers has talked about handing over control of the Bourne and Sagamore bridges to the state after replacing them.

"That's definitely something that's been in discussion," Craig Martin, the Corps' project manager in the New England District, said Thursday.

See BRIDGES, A4

The Corps released a draft report earlier this month recommending the bridges be replaced, and it is currently seeking public input on the potential project. Since the Corps has not definitely decided on replacement, no official memorandum of understanding between the Corps and the state has been made, he said.

"Nothing has been formalized," Martin said.

The bridges are the only two links for vehicles between the mainland and Cape Cod but are not what is typically found in the Corps' portfolio. The federal government acquired the Cape Cod Canal in 1928 and was authorized to build the bridges in 1933. The bridges were completed in 1935 and, at 84 years old, no longer meet modern roadway standards.

Most of the Corps bridges across the country are much smaller than the Bourne and Sagamore spans and normally connect to other infrastructure, such as dams.

"Typically the Corps doesn't manage traffic bridges like these," spokesman Timothy Dugan said.

A bridge similar to the Cape crossings that the Corps manages is the Sen. William V. Roth Jr. Bridge, which spans the Chesapeake & Delaware Canal. That bridge was used as a model for the proposed cross-sections of the Bourne and Sagamore replacements.

"We really only have a handful of really large bridges," Martin said.

The idea of divesting the bridges to the Massachusetts Department of Transportation has been discussed because the bridges are such a critical link for the state road network and traffic bridges are not usually part of the federal agency's core mission, he said.

But creating such a memorandum of understanding between the Corps and the state could be a long way off.

"We have to get to the decision first," Martin said of bridge replacement.

The Corps is still taking public comments on its draft report, which recommends building two six-lane bridges adjacent to the existing spans. The comment period ends Nov. 1, and a final report is slated to be done in February. A decision on whether to replace the bridges is not expected until the spring.

The project would ultimately have to be included in the Corps budget and be approved by Congress.

Massachusetts Sens. Edward Markey and Elizabeth Warren and the Cape's congressional representative, William Keating, sent a letter to the Army Corps on Thursday urging the federal agency to provide all of the necessary funding to replace the bridges in its 2020 work plan.

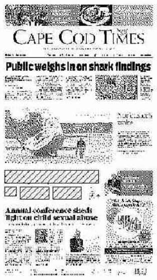
"These bridges connect the nearly 250,000 residents on the Cape and Islands to the rest of Massachusetts and connect the rest of the country to this beating heart of the Massachusetts tourism economy," the legislators' letter to Lt. Gen. Todd Semonite says.

"We believe that the new draft report represents significant progress toward addressing the construction needs of these two critical infrastructure projects, and ask that you devote the full resources necessary for completing this vital work," the letter states.

Allocating initial funds to solicit design and construction work would "represent a significant down payment and a responsible long-term investment in this critical infrastructure project."

The lawmakers also note a prospective divestment of the bridges to the state after their completion.

"We understand that the



© 2019 Dow Jones Local Media Group, Inc.
All Rights Reserved.

Account: 31366 (20175)
MA-117

For reprints or reuse, please e-mail sean.polay@dowjones.com or
send a letter to Sean Polay, Dow Jones Local Media Group, Box 580, Middletown, NY 10940

(Corps) will soon sign a memorandum of understanding with MassDOT that includes a plan to divest these federal bridges to state control after the (Corps') construction work is complete," they wrote. "The (Corps') investment of initial funds in FY 2020 will ensure that this process begins on schedule, avoids increasing costs brought on by project delays, and facilitates the state's takeover of these bridges as soon as possible. We applaud this goal because we believe it will lead to the best result for Massachusetts, while also helping to reduce the (Corp's) future workload and amounts spend on Operations and Maintenance."

The state Department of Transportation has a memorandum of understanding with the Corps that says the two agencies will collaborate through the project to replace the bridges, but it does not have a memorandum that specifies the department would take over ownership and maintenance of the two bridges, a department spokeswoman said via email.

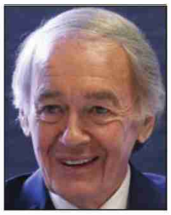
Markey hopes to get all major players on the project together in the coming weeks, according to his office.

The topics mentioned in the lawmakers' letter are not on the Corps' plate at the moment, Dugan said.

"A lot of this is well beyond where we are at," he said. "Our focus is finishing the report."

Follow Ethan Genter on Twitter: @EthanGenterCCT.

Martin



Markey

© 2019 Dow Jones Local Media Group, Inc.
All Rights Reserved.

For reprints or reuse, please e-mail sean.polay@dowjones.com or
send a letter to Sean Polay, Dow Jones Local Media Group, Box 580, Middletown, NY 10940

The Enterprise

Date: Saturday, November 02, 2019
Location: BROCKTON, MA
Circulation (DMA): 6,500 (9)
Type (Frequency): Newspaper (D)
Page: 3
Section: Main
Keyword: U.S. Army Corps of Engineers

Deadline extended for comment on Cape Cod Canal bridges project

By David Kindy

Have something to say about the planned construction of two new highway bridges over the Cape Cod Canal? You can still do so until Nov. 15.

The New England District of the Army Corps of Engineers has extended the deadline for public comment. Residents can make their thoughts known online, by email or via regular mail.

The Corps of Engineers announced last month that it will recommend constructing two new spans to replace the Sagamore and Bourne bridges, which are nearly 85 years old. It issued the Cape Cod Canal Highway Bridges Major Rehabilitation Evaluation Study outlining its recommendation.

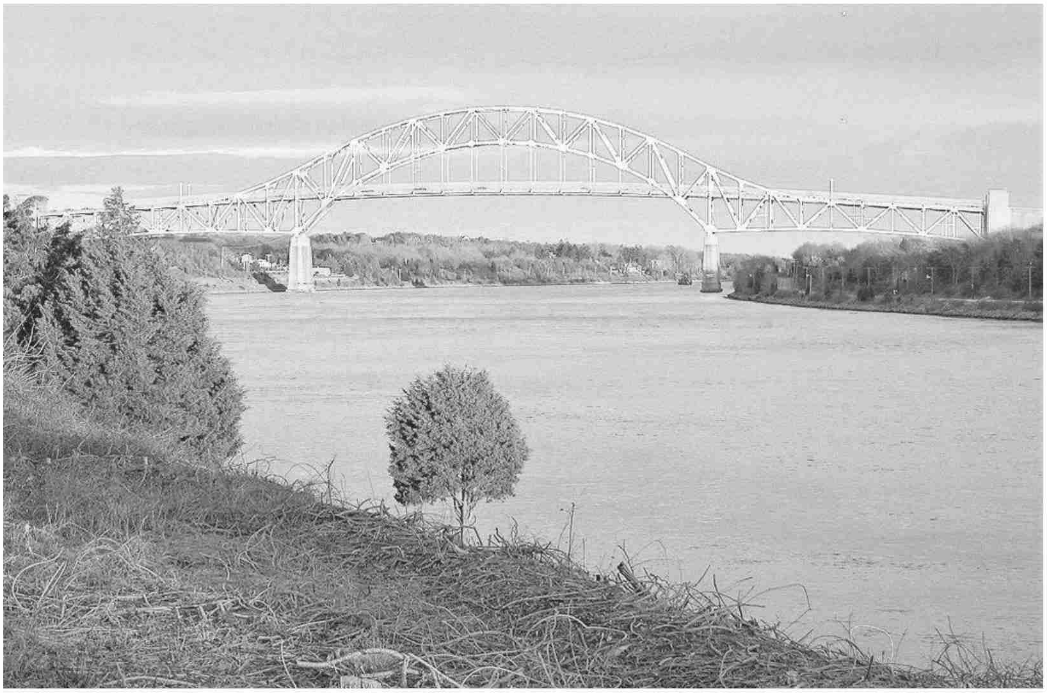
In the meantime, the Corps of Engineers began conducting public sessions to get input from people regarding their concerns about the project. One meeting was held Oct. 17 at Plymouth South High School for residents to learn about the work, which is estimated to cost more than $1 billion and could begin as soon as 2025.

The Corps of Engineers recommends replacing the two highway bridges with new structures built to include four authorized travel lanes and two additional auxiliary lanes for use as acceleration and deceleration lanes. The bridges would also include bicycle and pedestrian access.

In addition to public comment, the Major Rehabilitation Evaluation Study will undergo an independent external peer review by the private and academia sectors before. The final report will be submitted to Corps of Engineers headquarters in Washington, D.C., for a decision to be announced in February.

The Army Corps of Engineers will accept public comments on the draft study through Nov. 15. They can be submitted online at www.CapeCodCanalBridgesStudy.com, emailed to nae-pn-nav@usace.army.mil or sent in writing to U.S. Army Corps of Engineers, New England District, (Attn: Craig Martin), 696 Virginia Road, Concord, MA 01742-2751.

Reach David Kindy at dkindy@wickedlocal.com



FILE PHOTO

■ Sagamore Bridge, which spans the Cape Cod Canal, is one of the two canal bridges that is being considered for replacement.

© 2019 ENTERPRISE
All Rights Reserved.

DRAFT EA PUBLIC COMMENTS

This Page Intentionally Left Blank

Cape Cod Canal Highway Bridges Draft MRER/EA Comment Summary

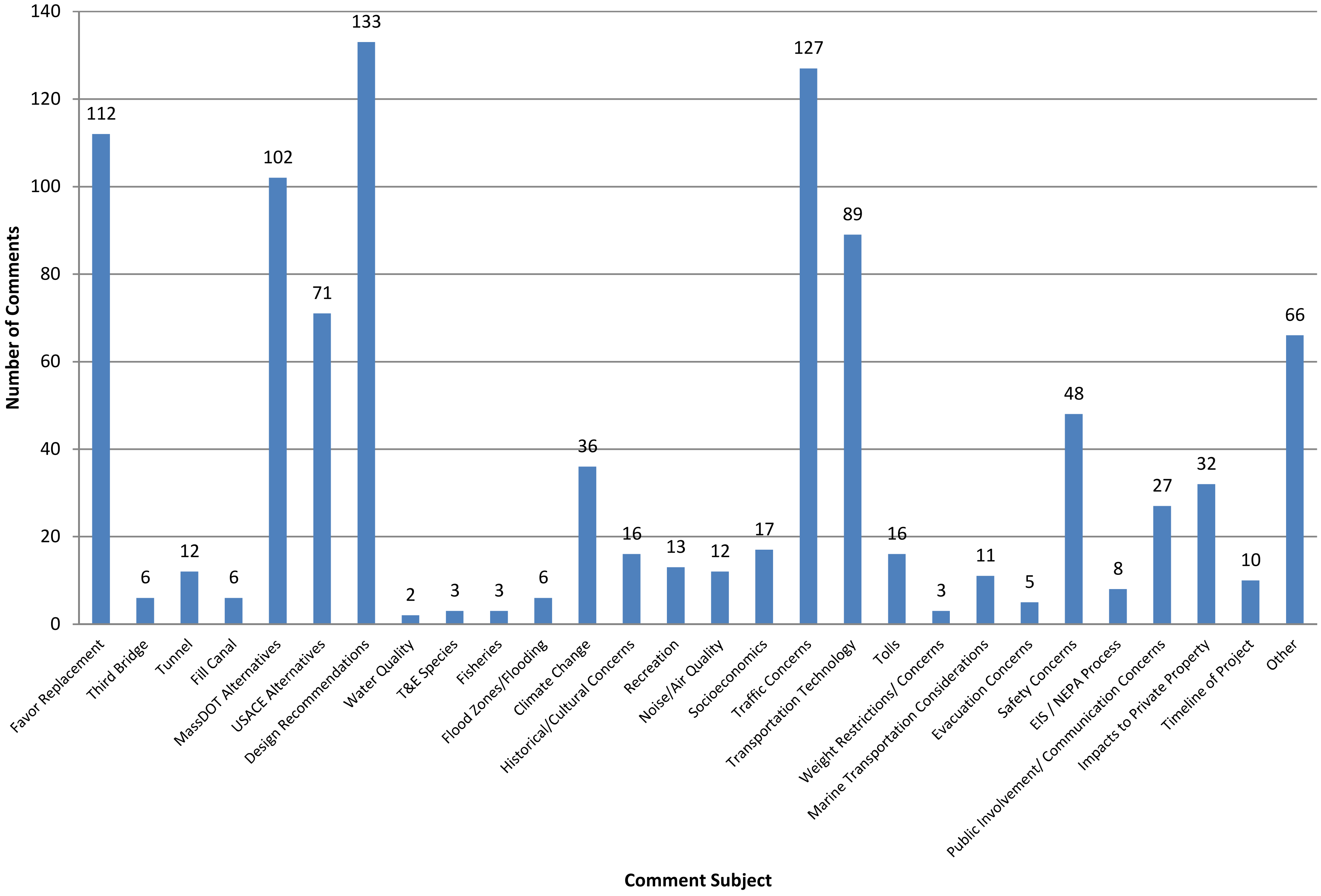


TABLE OF PUBLIC COMMENTS FOLLOWING DRAFT MRER/EA PUBLICATION

Comment #	Affiliation	Add to Mailing List (Yes/No)	Comment Date	Comment Type	Comment Subject																												Specific Comments/Questions
					ALTERNATIVES							ENVIRONMENTAL CONCERNS									TRANSPORTATION					OTHER							
					Favor Replacement	Third Bridge	Tunnel	Fill Canal	MassDOT Alternatives	USACE Alternatives	Design Recommendations	Water Quality	T&E Species	Fisheries	Flood Zones/Flooding	Climate Change	Historical/Cultural Concerns	Recreation	Noise/Air Quality	Socioeconomics	Traffic Concerns	Transportation Technology	Tolls	Weight Restrictions/ Concerns	Marine Transportation Considerations	Evacuation Concerns	Safety Concerns	EIS / NEPA Process	Public Involvement/ Communication Concerns	Impacts to Private Property	Timeline of Project	Other	
1		Yes	10/4/2019	Website											X																		Construction plans for the new bridges need to PAY ATTENTION TO THE CHANGING EVALUATION OF FLOOD PLAINS IN THIS AREA. No matter what you plan the environmental impact may not be significant for your construction YET THE ENVIRONMENTAL IMPACT OF TIDAL CHANGES MAY IMPACT A WIDER AREA BY THE TIME you have finished this project. I now life in a flood zone. It is real.
2		Yes	10/4/2019	Website	X					X	X										X												Being a Cape cod resident for almost my entire life, I have crossed these bridges more times than I can count. When crossing them the thought always hits you these need to be replaced. I've designed a couple different scenarios on how the new bridges should be designed but also the right direction to go during construction. Sagamore bridge: Has the perfect terrain for a 2 level bridge. The hill leading to the sagamore west bound of route 6 is almost setup to accommodate this. Lower level would be for oncoming cape cod traffic. Only set back is new bridge would have to take the place of the old bridge. Different design. Have 2 separate bridges one for one coming and one for off going traffic. Can build first bridge next to sagamore bridge once completed shift all travel west and east bound to new wider 4 lane bridge. Now Sagamore is free of traffic so it can be demoed and replaced with second bridge once all is completed split traffic into east and west bound one on one bridge other on the second. More money but would not cripple Cape Cod travel in peak seasons during construction. Bourne bridge is a prime candidate for this same design. New design would have to replace the rotary at the foot of the bridge. I am more than willing to discuss this in deeper detail if so requested.
3		Yes	10/4/2019	Website																	X												What is the plan or what will be offered to those residents immediately impacted and what is the plan to ensure no or minimal disruption to children who are being educated on either side of the bridge. The traffic delays and additional time spent in cars or buses for children I can see having a number of challenges and a need to consult with local schools and police to find a way to have a process as to allow for buses or parents with children to be able to be identified and able to access ways to circumvent the disruption this will cause. Additionally, are there other options when the waterway is closed down to be able covert the rail bridge or have another temporary solution or options? Lastly, when shutdowns occur will there be a way for additional road support approaching the bridges or re routed travel to ensure the back up and use of private roads is being monitored. As an example when there is work being done on the bridge there is a large amount of overflow or spill over on several roads that the local community relies on that become inaccessible impacting local business.
4		Yes	10/4/2019	Website	X																												
5		Yes	10/4/2019	Website	X																												
4		Yes	10/4/2019	Website		X				X	X																						If you\'re going to replace the bridges, either add a third bridge, or make the bridges big enough to stop bottlenecking traffic. Maybe 6 ot 8 lanes each bridge and widen the highway for a half mile or so.
5		Yes	10/4/2019	Website						X								X							X								We ought to be building lower and wider bridges to bring our communities closer together. The function of the canal other than recreation is obsolete. We no longer need the span and clearence of these bridges for commercial traffic. Redesign so that oil barges and recreational traffic can be accomodated as a maximum. And turn the canal region into a greater recreational area for the benefit of the region, the community and the nation.

TABLE OF PUBLIC COMMENTS FOLLOWING DRAFT MRER/EA PUBLICATION

Comment #	Affiliation	Add to Mailing List (Yes/No)	Comment Date	Comment Type	Comment Subject																												Specific Comments/Questions
					ALTERNATIVES							ENVIRONMENTAL CONCERNS									TRANSPORTATION					OTHER							
					Favor Replacement	Third Bridge	Tunnel	Fill Canal	MassDOT Alternatives	USACE Alternatives	Design Recommendations	Water Quality	T&E Species	Fisheries	Flood Zones/Flooding	Climate Change	Historical/Cultural Concerns	Recreation	Noise/Air Quality	Socioeconomics	Traffic Concerns	Transportation Technology	Tolls	Weight Restrictions/ Concerns	Marine Transportation Considerations	Evacuation Concerns	Safety Concerns	EIS / NEPA Process	Public Involvement/ Communication Concerns	Impacts to Private Property	Timeline of Project	Other	
6		Yes	10/4/2019	Website					X	X	X										X												I see no point in adding more lanes then the oncoming roads have or Route 6 can accommodate. There should be a designated lane in each direction for residents with stickers or passes similar to Easy Pass. A bike/pedestrian bridge should be a separate lighter bridge for safety.
7		Yes	10/4/2019	Website																				X								X	Taking notice of the bridge section view, in particular the cantilevered pedestrian and bicycle lane (e.g. Fig.27 on Pg. 136), I have a question for the structural engineers: regarding live loads, how heavy a snow plow truck can the cantilevered lane handle when there is public outcry to remove snow and ice to enable use in the winter months?
8		No	10/4/2019	Website					X												X												The idea of a multi-lane bridge crossing onto the Cape is great, but where will the cars go once they are over the bridge? What changes will be made to the rotary at the Cape end? Adding good bus service, train service, as well as the bike and pedestrian access would be a better use of funds and allow more people to enjoy the natural beauty of the area.
9		Yes	10/4/2019	Website	X																X												I fully support this project! These bridges are old and traffic also backs up as a result. Hopefully this will help to fix so many issues, including the cost to fix and maintain these old bridges.
10	Mass Registry of Motor Vehicles	Yes	10/4/2019	Website																												X	Looking forward to reading the study. Great logo & website!
11		Yes	10/4/2019	Website	X				X		X										X												The Bridges definitely need to be replaced. The Bridges traffic lanes need to be 6 lanes on each and much wider to accommodate trailers, 18 wheelers, buses, moving vans etc to be side by side with a smaller vehicle passing over without crowding them out. What happens at the Bourne Rotary?
12		No	10/4/2019	Website	X						X										X												It would be great if we could have three lanes on each side of the new bridge, and also think about widening the land side of the entering lanes to two left lanes plus the right side lane, instead of the two individual lanes that currently merge awkwardly and dangerously, and really slows down the traffic.
13		Yes	10/4/2019	Website							X						X																I agree that the current bridges are small for the volume of traffic, and I have noted the frequency of repairs in recent years. However, I also believe the bridges have become icons of the Cape, much as the Empire State Building is to New York City, or the Golden Gate to San Francisco. I feel, therefore, that if the bridges must be replaced it should be done in a way that preserves their current appearance. A "modern" design (such as in the new Champlain Bridge between NY and VT) dimly would not fit in, and would be a sad loss of a sight millions of visitors associate with one of the most famous destination in the United States.
14		Yes	10/4/2019	Website	X																												I am very supportive of replacing these two very old bridges. They are way past the time when they should have been replaced in my opinion and this project should be put in the fastest track possible.
15		No	10/4/2019	Website	X					X													X				X						This is a necessary step in ensuring public safety. Perhaps a redesign which would either add lanes, create safe walking/biking lanes, and/or a resident/commercial express deck or lane. The last suggestion could act as a revenue center as it would require a (reasonably priced) sticker and not be a toll.
16		Yes	10/4/2019	Website																	X												Will they be adding more lanes to improve traffic flow; and if so, how many lanes are being considered?
17		Yes	10/4/2019	Website	X																						X						We really have been waiting for this day. Our safety and well being are jeopardized by the bridges and it is really important we can look forward to newer safer less congested bridges.
		Yes	10/4/2019	Website																												X	Please add me to your mailing list.

TABLE OF PUBLIC COMMENTS FOLLOWING DRAFT MRER/EA PUBLICATION

Comment #	Affiliation	Add to Mailing List (Yes/No)	Comment Date	Comment Type	Comment Subject																												Specific Comments/Questions
					ALTERNATIVES							ENVIRONMENTAL CONCERNS									TRANSPORTATION					OTHER							
					Favor Replacement	Third Bridge	Tunnel	Fill Canal	MassDOT Alternatives	USACE Alternatives	Design Recommendations	Water Quality	T&E Species	Fisheries	Flood Zones/Flooding	Climate Change	Historical/Cultural Concerns	Recreation	Noise/Air Quality	Socioeconomics	Traffic Concerns	Transportation Technology	Tolls	Weight Restrictions/ Concerns	Marine Transportation Considerations	Evacuation Concerns	Safety Concerns	EIS / NEPA Process	Public Involvement/ Communication Concerns	Impacts to Private Property	Timeline of Project	Other	
18		Yes	10/4/2019	Website							X						X				X											X	Design should mirror existing structures. My grandfather worked on the Sagamore and his and all who worked on Sagamore and Bourne Bridges should be honored. As a native cape codder the sight of of the bridges was a welcomed sight and meant I was almost home. Can we keep the existing bridges for pedestrians, bicycles and sightseeing, and emergency vehicles and situations. I just moved off cape to Onset because bridge traffic had become so bad.
19		Yes	10/4/2019	Website					X		X										X												The problem(s) with the Sagamore Bridge are the entrance ramps right before the bridge going eastbound where Rt 3 gets cut down from 2 lanes to one to allow merging traffic to come on. The problem with the bridge westbound is that people use 6A as a shortcut alternative to Rt 6 with a large number of people try to merge on right before the Christmas Tree Shop which again results in 3 lanes (2 from Rt 6 West and one from the ramp from the Cranberry Highway) merging on, hence a backup. I will grant you that the bridge is too narrow and drivers get nervous in the left lane, especially when a truck approaches which forces them to reduce their speed. I think if you somehow reconfigure Rt 6 westbound and Rt 3 coming into the Sagamore to eliminate shortcuts (entrance ramps right before the bridge in BOTH directions) and force people to merge on way further up the way (miles) before the bridge with NICE, long high speed merge lanes, the problem for the most part will be fixed.
20		Yes	10/4/2019	Website	X						X																						Great (and well thought out) recommendation! BUT - why only 4 travel lanes?? I would think at a minimum there should be 6, plus any auxiliary lanes. I think it would be so foolish to not capitalize on brand new construction to enhance the sole passenger travel arteries to & from Cape Cod.
21		Yes	10/4/2019	Website	X						X										X												I am recommending that the Sagamore bridge have 4 lanes (total 8 lanes) for each directions which includes the additional auxiliary lanes connecting both end of the bridges at Route 3 and 6 with the cut off point at exit 2 in order to facilitate the flow the traffic as called for by the Mass DOT Canal Study. The extra lane on the bridge can be used for the entrance of exit 1C without interfering with the approaching traffic. The Bourne Bridge needs 4 lanes (total 8 lanes) both directions with flyovers to connect the Scenic Highway and canal road as called for by the Mass DOT Canal Study.
22		Yes	10/4/2019	Website																											X		I heard on the news today 10/4/19 that this will not start until 5 yrs. from now. How ridiculous is that.
23			10/4/2019	Website				X																									Why not just fill in the canal?
24			10/4/2019	Website	X						X						X																Try to retain the look and feel of the existing bridges in the new one. And only demolish one bridge at a time.
25		Yes	10/4/2019	Website	X																												I certainly hope that the decision is to replace the bridges. Also, I ask that the existing bridges Both remain active during the entire duration of the replacement.
26		Yes	10/4/2019	Website	X		X		X		X																						Living on Cape Cod and knowing that the bridges need an overhaul I would recommend a three-phase project. Part 1: A tunnel from the coast of Plymouth in Manomet area (taking that left hand exit off Route 3 @ Exit 4) that takes commuters out to around Exit 6 of Mid-Cape under the deeper Cape Cod Bay). Most of the summer commuters head to Exit 6 or beyond. This would also alleviate a lot of traffic from the Sagamore Bridge. Part 2: Replace the Sagamore Bridge with wider lanes (two each way plus biking and walking access). Part 3: Replace Bourne Bridge with 3 lanes each way.
27		Yes	10/4/2019	Website	X																												Please replace both bridges.

TABLE OF PUBLIC COMMENTS FOLLOWING DRAFT MRER/EA PUBLICATION

Comment #	Affiliation	Add to Mailing List (Yes/No)	Comment Date	Comment Type	Comment Subject																												Specific Comments/Questions
					ALTERNATIVES							ENVIRONMENTAL CONCERNS									TRANSPORTATION					OTHER							
					Favor Replacement	Third Bridge	Tunnel	Fill Canal	MassDOT Alternatives	USACE Alternatives	Design Recommendations	Water Quality	T&E Species	Fisheries	Flood Zones/Flooding	Climate Change	Historical/Cultural Concerns	Recreation	Noise/Air Quality	Socioeconomics	Traffic Concerns	Transportation Technology	Tolls	Weight Restrictions/ Concerns	Marine Transportation Considerations	Evacuation Concerns	Safety Concerns	EIS / NEPA Process	Public Involvement/ Communication Concerns	Impacts to Private Property	Timeline of Project	Other	
		Yes	10/4/2019	Website																												X	Following.
28		Yes	10/5/2019	Website																							X					X	In 2008 I informed a Representative from the Army Corp of Engineers that the Sagamore Bridge, from my observation from RT3A (State Rd), in Sagamore, was listing to the right. It remains my observation still today. I received no response at the time except we will look into it.
29		Yes	10/5/2019	Website																												X	Minimize this states political staff involvement, they will screw everything up for their own personal, reasons, and to help benefit them politicaly. Look at the big dig that's a prime example.
30		Yes	10/5/2019	Website							X															X	X						First, the bridges are the only evacuation route. The number of available lanes is critical. Consider what happens if there were to be a major accident at a critical time. It would be likely; as people rarely think clearly at critical times. It seems to me that if an undertaking like this is going to happen anyway, it would make economic sense to have another lane in each direction, AT MINIMUM. I would like to see four in each direction. You can't add lanes later. Don't make the same mistake as the Big Dig, where they replaced three lanes in either direction with a roadway that still has choke points of three lanes in either direction! Extra lanes will always help when it\'s time for future maintenance, as well. Also, build these bridges like you mean them to stand for 100 years; The existing ones were only meant to stand 50 years and will probably be 100 years old by the time they come down.
31		Yes	10/5/2019	Website	X						X																						Long overdue for the bridges to be replaced with additional traffic lanes. Should consider eight lanes versus six for long term economic sustainability of the region.
32		No	10/5/2019	Website	X																												In full support of replacing the bridges - this is long overdue.
33		Yes	10/5/2019	Website	X						X			X		X																	This is long overdue. Please consider implementing solar on the bridge for lighting power. Consider raising all bridges and roads to accommodate future sea level rise. Consider building "habitat homes" into the bridge footings so that fish, lobsters crabs have nooks and crannies to live in.
34		Yes	10/5/2019	Website	X				X														X				X						1) make new bridges toll bridges so that people coming to Cape Cod help pay for our depletion of our natural resources, at least for non mass residents or for all vehicles with some type of compensation for Cape Cod residents , 2) do away with the rotary which is very dangerous and 3) eliminate a bike path on the bridges which will cause many injuries.
35		Yes	10/5/2019	Website	X					X	X																						It makes sense to replace the Sagamore and Bourne bridges. The lanes are narrow and I have worried about head on crashes because there is no median. I have also driven over the George Washington bridge and Verrazano Narrows Bridge many many times. I always wondered why the Cape bridges were not double decker bridges like those spans. For the Cape bridges you could have one deck for on Cape traffic and one for off Cape traffic. No need for medians as vehicles on each level are going same direction. In future when Bridge roads need resurfacing could you close entire upper deck (making work quicker) and temporarily re route all traffic to lower deck? Seems two decks allows more flexibility. I saw a study along time ago that it was less expensive to build the GW Bridge with lanes on two levels than same number of lanes as one level bridge. Same economy of scale apply to Cape Cod bridges?
		Yes	10/5/2019	Website																												X	Joining mailing list for project awareness only at this time.

TABLE OF PUBLIC COMMENTS FOLLOWING DRAFT MRER/EA PUBLICATION

Comment #	Affiliation	Add to Mailing List (Yes/No)	Comment Date	Comment Type	Comment Subject																												Specific Comments/Questions
					ALTERNATIVES							ENVIRONMENTAL CONCERNS									TRANSPORTATION					OTHER							
					Favor Replacement	Third Bridge	Tunnel	Fill Canal	MassDOT Alternatives	USACE Alternatives	Design Recommendations	Water Quality	T&E Species	Fisheries	Flood Zones/Flooding	Climate Change	Historical/Cultural Concerns	Recreation	Noise/Air Quality	Socioeconomics	Traffic Concerns	Transportation Technology	Tolls	Weight Restrictions/ Concerns	Marine Transportation Considerations	Evacuation Concerns	Safety Concerns	EIS / NEPA Process	Public Involvement/ Communication Concerns	Impacts to Private Property	Timeline of Project	Other	
36		Yes	10/5/2019	Website	X				X		X										X												I am pleasd to know the 2 bridges are being considered for replacement. My concern however is the on-ramps to the Sagamore, particularly the Cape Cod Side heading West. It's always been apparent that a large problem of the backup is due to the on ramp coming onto the bridge in Sandwich right in front of the Christmas Tree Shop. I gather the thought was not to distrupt the traffic flow for business for the Christmas Tree Shop however that should not have ever been a concern. I hope you and the Massachusetts consultants will be removing that on ramp from that location entirely now.
37		No	10/5/2019	Website	X				X		X										X												In the case of the Bourne bridge, the major problem is not just the bridge itself, but the rotary as well. Traffic jams up around the rotary due to most cars going around to take the exit that connects to 6A. This blocks the outbound traffic severely and creates a second traffic jam exiting Rt. 28 NB to the rotary. The second problem is the lack of a third travel lane on either side of the bridge, especially 28 SB. Many cars are coming from the exit from the Wareham rotary, and the traffic jams when they try to merge. My view is that the Bourne Bridge replacement should be a six-lane, center suspended, cable stayed bridge, which stays elevated over the current location of the rotary, and has exits from the right-most lane down to the former location of the rotary, where the two sides would simply be connected across. Since much of the traffic is going to 6A, that traffic would be redistributed to the right-most lane, leaving space for 28s traffic in the other two lanes. This design would also eliminate the rotary which is inherently prone to traffic jams, and would be easier to use for out of state drivers, especially southern drivers, who do not know how to properly use a rotary.
38		Yes	10/5/2019	Website	X				X		X										X						X						I am a lifelong resident of the Cape Cod Canal area and know firsthand about the traffic and safety concerns surrounding the two bridges. It is absolutely essential that the new replacements provide three lanes in both directions as well as bicycle lanes and sidewalks which will provide for traversing issues now as well as the distant future. I believe the new bridges should be built in the same location as the existing so as to avoid major alterations to the existing bridge approaches. Mass Highway needs to be involved with this project with their own upgrades and development. Three contributing projects should take place before and/or during bridge construction (A. Elimination of the the Bourne rotary on the south side of the canal, (B. a Belmont rotary bypass road from Scenic Highway to Rt. 25a and also a third lane added to the South side of the Sagamore bridge all the way up to the first exit. If these projects are added they would significantly ease traffic congestion and safety.
39		Yes	10/5/2019	Website																												X	Can you please send me back a copy of my comment along with any additional comments .thank you.
40		Yes	10/5/2019	Website	X				X												X												In the long run, I would advocate for replacement. However, not before adequate highway approach from both sides is thoroughly studied. The so-called Sagamore Flyover is far from that and an accident on the Cape side rotary of the Bourne Bridge can be an interminable nightmare. To me the best solution, along with replacement, is a high speed monorail down Rt. 3, across the canal, and on to Provincetown. We should be investing in such transportation both west and north of Boston as well.
41		Yes	10/5/2019	Website							X										X												Just a suggestion but it would be nice to include full-sized breakdown Lanes on both bridges. This will help traffic continue moving when any type of vehicle breaks down and is able to move over completely out of the way. The current bridges never had the room to include this and traffic was horrendous when there was any type of breakdown.
42		Yes	10/6/2019	Website							X										X												I think the new bridges should have more than 2 lanes in each direction, or we will have the same traffic jams that we have now.

TABLE OF PUBLIC COMMENTS FOLLOWING DRAFT MRER/EA PUBLICATION

Comment #	Affiliation	Add to Mailing List (Yes/No)	Comment Date	Comment Type	Comment Subject																												Specific Comments/Questions
					ALTERNATIVES							ENVIRONMENTAL CONCERNS									TRANSPORTATION					OTHER							
					Favor Replacement	Third Bridge	Tunnel	Fill Canal	MassDOT Alternatives	USACE Alternatives	Design Recommendations	Water Quality	T&E Species	Fisheries	Flood Zones/Flooding	Climate Change	Historical/Cultural Concerns	Recreation	Noise/Air Quality	Socioeconomics	Traffic Concerns	Transportation Technology	Tolls	Weight Restrictions/ Concerns	Marine Transportation Considerations	Evacuation Concerns	Safety Concerns	EIS / NEPA Process	Public Involvement/ Communication Concerns	Impacts to Private Property	Timeline of Project	Other	
43		Yes	10/6/2019	Website					X		X										X												Since drivers go from a 2 lane approach to the bridge to a two lane continuation on the Cape, I find there is no reason to create 4 lanes of driving traffic each way on the bridge. It would just bottle neck on the bridge. Consequently, I would favor new construction of 2 lanes each way for drivers with a bike/pedestrian lane separated with dividers from the driving traffic. This would, of course, be for both going onto and off the Cape.
44		Yes	10/7/2019	Website				X																							X		How long would it take to construct these bridges and has there been a consideration of filling in the canal?
45		Yes	10/7/2019	Website																	X					X	X						When you look at traffic patterns and the stability of the bridges, I hope you will consider the needs and safety of Cape residents *more than* the tourists that drive here. We need accessibility over the bridge for resident employment / other issues, as well as transportation of goods and services to our communities. We need the bridges as a dependable route for emergency evacuations in the event of a 100-year storm.
46		Yes	10/7/2019	Website						X	X																						When the Bridges were designed they were influenced by 1930\'s Art Deco movement, a classic design of the era. Has anyone considered saving money on the new bridges by eliminating the cost of constructing bike and walking paths and keeping the new bridges for vehicles only. Then saving one or both bridges solely for pedestrian and bike traffic. This would be similar to the High Line in NYC, where he city saved an elevated highway and repurposed it into a pedestrian walkway.
47		Yes	10/8/2019	Website																									X	X			None of the abutter and neighboring businesses have been notified of any of the plans. The cape cod chamber of commerce and canal chamber of commerce are not sharing ANY information with members and abutters along the route.
48		Yes	10/9/2019	Website					X																							X	Perhaps instead of one or both bridges across the Cape Cod Canal they could offer a short ferry ride that ran as frequently as necessary. Also, I believe the geologic force to be from the east-southeast. I have seen evidence of it in the Medford, Mass. area. And I generalize it to there.
49		Yes	10/9/2019	Website	X																	X										X	These bridge lanes are too narrow. Replacing the bridges will be a nightmare but the end result worth it! My husband suggested looking into a possible option of running ferrys with passengers and vehicles from Plymouth and Quincy to various parts of the Cape to help with some of the traffic during construction.
50		Yes	10/9/2019	Website	X																						X						Please replace these antiques with modern, safe structures.
51		Yes	10/9/2019	Website	X						X										X												Thanks to the Army Corp of Engineers in their efforts to create a new set of bridges over the Cape Cod Canal that would bring those sections of roadway into the twenty-first century. Wouldn't it also make sense to include in the design a railway tracks similar to the Longfellow Bridge that connects Cambridge to Boston. The New Bourne Bridge could incorporate existing rail lines to extend the MBTA Middleboro train service into North Falmouth. On the Sagamore Bridge the MBTA Kingston line could be extended along Route 3 over the canal continuing down Route 6 to the Lorenzo Sand and Gravel site in Hyannis or possibly on to Orleans.

TABLE OF PUBLIC COMMENTS FOLLOWING DRAFT MRER/EA PUBLICATION

					Comment Subject																												
					ALTERNATIVES							ENVIRONMENTAL CONCERNS									TRANSPORTATION					OTHER							
Comment #	Affiliation	Add to Mailing List (Yes/No)	Comment Date	Comment Type	Favor Replacement	Third Bridge	Tunnel	Fill Canal	MassDOT Alternatives	USACE Alternatives	Design Recommendations	Water Quality	T&E Species	Fisheries	Flood Zones/Flooding	Climate Change	Historical/Cultural Concerns	Recreation	Noise/Air Quality	Socioeconomics	Traffic Concerns	Transportation Technology	Tolls	Weight Restrictions/ Concerns	Marine Transportation Considerations	Evacuation Concerns	Safety Concerns	EIS / NEPA Process	Public Involvement/ Communication Concerns	Impacts to Private Property	Timeline of Project	Other	Specific Comments/Questions
52	MA. Div. of Fish and Wildlife	Yes	10/11/2019	Website									X																				NHESP 19-38452: Cape Cod Canal Bridges Thank you for soliciting comments from the Massachusetts Division of Fisheries and Wildlife for the above referenced project. Based on the Map and the Study Areas that were identified, the locations are not within Priority Habitat as of the 14th Edition of the Natural Heritage Atlas. For more information, please see the link below. https://www.mass.gov/service-details/ma-endangered-species-act-mesa-overview https://www.mass.gov/service-details/regulatory-maps-priority-estimated-habitats It is important to note that there has been Peregrine Falcons (Falco peregrinus) nesting on the bridges. Most recently nesting on the Bourne Bridge. The peregrine falcon is state-listed as Threatened. This species and its habitats are protected pursuant to the MESA. Fact sheets for state-listed species can be found at www.mass.gov/nhesp. https://www.mass.gov/files/documents/2016/08/qe/falco-peregrinus.pdf The Division looks forward to continued coordination with the U.S. Army Corps of Engineers as the project advances in order to minimize impacts to nesting falcons during construction as well as identifying possible proactive opportunities that could be incorporated into final designs. Please let me know if there are any questions. Sincerely, David Paulson Senior Endangered Species Review Biologist Massachusetts Division of Fisheries & Wildlife 1 Rabbit Hill Road, Westborough, MA 01581 p: (508) 389-6366 | e: david.paulson@state.ma.us mass.gov/masswildlife | facebook.com/masswildlife
53	Bourne, Town of	Yes	10/11/2019	Website																									X				I would like to formally request that at least one Town of Bourne representative, chosen by the Bourne Board of Selectmen, be added to your US Army Corp of Engineer bridges study committee/team. As Bourne is the host community for these major projects, it should have representation on this committee to provide a direct line of communication between the Town and the Study Group and vice versa. It will tremendously benefit all parties involved. Thank you, Jim Potter Vice Chairman, Bourne Board of Selectmen
54		Yes	10/12/2019	Website						X	X																						Faced with replacing an aging, too-narrow steel bridge of similar (iconic) design as the canal ones, Vermont\'s solution for the I-89 span over the Winooski River in Richmond was to slice the bridge lengthwise and widen it by adding girders, thereby retaining the orig. design. Admittedly, it was a MUCH smaller and less complicated span. How about adding one lane outside the existing bridge (with no overhead steel) and alternating its use like the HOV lanes on rt. 93?
55		Yes	10/14/2019	Website					X																					X			When will the bridges approach road plans and anticipated homes that will be impacted be made public?
56		Yes	10/16/2019	Website					X		X																						Could 28 be a flyover enabling traffic to flow without engaging in the traffic circle?
57	Bourne Board of Selectmen	Yes	10/16/2019	Public Meeting																									X				Sagamore resident. Insisted a delegation of Bourne representatives be present at all design meetings and processes. Stated the delegation would be coordinated by Board of Selectmen and Town Administrator. Said, “It is time to have more engagement with Bourne.” Requested that USACE and MassDOT work together with the Bourne Board of Selectmen in order to work out public engagement schedule with various stakeholders. Suggested December 3rd, 2019 as possible meeting date.

TABLE OF PUBLIC COMMENTS FOLLOWING DRAFT MRER/EA PUBLICATION

Comment #	Affiliation	Add to Mailing List (Yes/No)	Comment Date	Comment Type	Comment Subject																												Specific Comments/Questions
					ALTERNATIVES							ENVIRONMENTAL CONCERNS									TRANSPORTATION					OTHER							
					Favor Replacement	Third Bridge	Tunnel	Fill Canal	MassDOT Alternatives	USACE Alternatives	Design Recommendations	Water Quality	T&E Species	Fisheries	Flood Zones/Flooding	Climate Change	Historical/Cultural Concerns	Recreation	Noise/Air Quality	Socioeconomics	Traffic Concerns	Transportation Technology	Tolls	Weight Restrictions/ Concerns	Marine Transportation Considerations	Evacuation Concerns	Safety Concerns	EIS / NEPA Process	Public Involvement/ Communication Concerns	Impacts to Private Property	Timeline of Project	Other	
58	Bourne, Town of	Yes	10/16/2019	Public Meeting	X																								X				Bourne resident. Believes the correct choice is to replace the bridges. Encouraged agencies to work together with the town of Bourne throughout the design process.
59	Bourne Recreation Authority	Yes	10/16/2019	Public Meeting														X											X				Bourne resident. Stated that the Bourne Recreation Authority would like to work with the groups involved. Explained that Bourne Scenic Park and Gallo Ice Arena are both on USACE owned property. Wants both the park and rink to be identified during the planning stages. Said, "We want a seat at the table."
60	Cape Cod Commission	Yes	10/16/2019	Public Meeting																									X			X	Barnstable resident. Encouraged dialogue with the towns in the identified area. Worries about the local and regional concerns that replacement of the bridges presents.
61		Yes	10/16/2019	Public Meeting	X											X	X														X		Sandwich resident. Supports the replacement plan as recommended. Appreciated the design to include sea level rise. Explained she wished for the preservation of the Cape Cod Canal. Supported the start date of the replacement before 2025.
62	Cape Cod Technology Council	Yes	10/16/2019	Public Meeting	X																												Bourne resident. Urged the implementation of the replacement plan as expeditiously as possible.
63		Yes	10/16/2019	Public Meeting					X	X																				X			Bourne resident. Worried that his property will be impacted by the construction of the bridges. Wondered about any alternatives that may arise.
64		Yes	10/16/2019	Public Meeting					X												X												Sagamore resident. Recommended the public read the report put out by USACE regarding the replacement project. Worried that the new bridges would not solve the current traffic problem. Asked if the USACE will work with MassDOT and the Federal Highway Administration to produce the best possible outcome and whether any of the MassDOT proposed alternatives to relieve traffic congestion would be constructed prior to construction of the new bridges
65		Yes	10/16/2019	Public Meeting		X															X		X									X	Sagamore resident. Worried about whether the traffic would change or not. Wondered about whether the cost included the cost to commerce during the construction of the new bridges. Believed a third bridge would still be a viable option and offered that tolls would be a helpful way to pay for the cost of construction.
66		Yes	10/16/2019	Public Meeting		X																							X	X			Sagamore resident. Agreed with the idea of a third bridge option. Believed that more consideration should be given to those who have been residents their whole lives. Would like collaboration and contact with homeowners presumed to be affected.
67		Yes	10/16/2019	Public Meeting	X																												South Yarmouth resident. Fully supported the replacement plan, as he believed the option of rehabilitating the current bridges would cause irreparable harm to the Cape and Islands.
68		Yes	10/16/2019	Public Meeting							X										X											X	Marstons Mills resident. Concerned that the current design did not show median dimensions. Was curious if the new bridges would look like the Braga Bridge in Somerset, Massachusetts. Stated that maybe an underpass connecting Market Basket and Christmas Tree Shops would lessen traffic in the area. Wondered if there was any plan to remove the railroad bridge due to the new proposed bridges being higher than existing bridges.
69		Yes	10/16/2019	Public Meeting		X					X										X	X											East Falmouth resident. Stated that there should be three bridges instead of two. Explained how he believes the study is biased towards what was desired back in 1934 upon original bridge creation. Believed that the need to get rid of the car traffic far exceeds the need to account for the minimal commercial boat traffic the canal faces. Stated that using some land from Joint Base Cape Cod would be a good idea. Explained that the new bridges need more lanes, and there isn't a need to account for bikers and pedestrians on the bridge due to the small number of them that cross the bridges. Noted that a highspeed rail line should be considered as an option

TABLE OF PUBLIC COMMENTS FOLLOWING DRAFT MRER/EA PUBLICATION

Comment #	Affiliation	Add to Mailing List (Yes/No)	Comment Date	Comment Type	Comment Subject																												Specific Comments/Questions
					ALTERNATIVES							ENVIRONMENTAL CONCERNS									TRANSPORTATION					OTHER							
					Favor Replacement	Third Bridge	Tunnel	Fill Canal	MassDOT Alternatives	USACE Alternatives	Design Recommendations	Water Quality	T&E Species	Fisheries	Flood Zones/Flooding	Climate Change	Historical/Cultural Concerns	Recreation	Noise/Air Quality	Socioeconomics	Traffic Concerns	Transportation Technology	Tolls	Weight Restrictions/ Concerns	Marine Transportation Considerations	Evacuation Concerns	Safety Concerns	EIS / NEPA Process	Public Involvement/ Communication Concerns	Impacts to Private Property	Timeline of Project	Other	
70		Yes	10/16/2019	Public Meeting															X										X	X			Sagamore resident. Worried that the construction of the new proposed replacement bridges would cause his property to be taken, or sleep disruption, or affect his livelihood. Explained he would like the be kept up to date throughout the decision making and design process.
71		Yes	10/16/2019	Public Meeting																	X							X				X	Chatham resident. Worried that the study does not accurately explain that all Cape residents will be affected. Questions a point within the Environmental Assessment on page 100, where it is stated that no substantial increase in traffic will occur. He believes that cannot be accurate as it will allow more people to have an easier time traveling further down the Cape. There has got to be an environmental impact statement that details how this project is going to affect the region and not just the Canal region.
72		No	10/16/2019	Public Meeting							X																X					X	Local Bicylclist. Explained that the new bridges will need to have adequate sidewalks that allow easy transportation to USACE multi-use trails and other bike routes. Stated that proper signage is required. Claimed that during the construction period there should be alternatives available for bikers/pedestrians looking to cross the bridges. Explained that MassDOT should be involved in the creation of approved public railroad crossings for bikes and pedestrians.
73	Represenative for Congressman Bill Keating	No	10/16/2019	Public Meeting																									X				Read a prepared statement from Keating. Wanted USACE to work closely with groups, residents and locals during the entire process.
74		Yes	10/16/2019	Public Meeting	X																											X	Wondered if the design had taken the transportation needs of the military at Joint Base Cape Cod into consideration. Questioned that if the design lessens the need for the railroad access to Joint Base Cape Cod, would there be a plan to get rid of the railroad, which is used for emergency purposes, but he stated that it "holds properties hostage" for this contingency.
75		No	10/16/2019	Public Meeting																										X			Explained he did not realize there would be residents' homes that would need to be taken in order to replace bridges. Stated that he believes the government is "overreaching" and should expect pushback from the residents for this reason.
76		Yes	10/17/2019	Public Meeting						X	X										X								X	X			Local abutter. Voiced his concerns over the construction of the new replacement bridges and how the process has made him anxious. Explained that he is puzzled that local merchants including himself have yet to be notified of the project. Claimed that residents are not receiving the information they need. Stated that the closing of Exit 1 westbound has him worried for his business. Explained that the solution needs to take care of local traffic. Stated he looks forward to hearing more scientific findings that may arise.
77		No	10/17/2019	Public Meeting																	X							X	X			X	Chatham resident. Voiced his concerns over the Environmental Assessment, and how it has been assessed based on natural and human environment. Further questioned what they looked at during the assessment to come to their conclusions, stating that he was unable to find any data relating to the impacts that the outer Cape, mid Cape, and lower Cape may face due to the replacement of the bridges. Questioned further how the traffic would or would not change due to the new replacement bridges, stating that an increased bridge size will be able to accommodate an increase volume of traffic coming over the bridges which would mean more traffic down the Cape. Explained that the study showed data for how the Bourne bridge will be affected but there was no data for the Sagamore. Wondered if there was data some place on the affects, where could he find it. Worried that if there are no numbers available, then there cannot be any feedback given regarding decisions and designs of the bridges.

TABLE OF PUBLIC COMMENTS FOLLOWING DRAFT MRER/EA PUBLICATION

Comment #	Affiliation	Add to Mailing List (Yes/No)	Comment Date	Comment Type	Comment Subject																												Specific Comments/Questions
					ALTERNATIVES							ENVIRONMENTAL CONCERNS									TRANSPORTATION					OTHER							
					Favor Replacement	Third Bridge	Tunnel	Fill Canal	MassDOT Alternatives	USACE Alternatives	Design Recommendations	Water Quality	T&E Species	Fisheries	Flood Zones/Flooding	Climate Change	Historical/Cultural Concerns	Recreation	Noise/Air Quality	Socioeconomics	Traffic Concerns	Transportation Technology	Tolls	Weight Restrictions/ Concerns	Marine Transportation Considerations	Evacuation Concerns	Safety Concerns	EIS / NEPA Process	Public Involvement/ Communication Concerns	Impacts to Private Property	Timeline of Project	Other	
78		Yes	10/17/2019	Public Meeting					X												X							X					Plymouth resident. Explained how he was pleased that MassDOT and the USACE worked together on the project. Wondered if some permitting processes were to be held up, how would this affect the building process. Worried that the secondary impacts of the bridges replacement project may be glossed over. Stated that with more people moving to the South Shore, and with traffic getting worse everywhere south of Boston, would new larger bridges mean more people visiting. Explained how MassDOT should look into the idea of widening Route 3.
79		Yes	10/17/2019	Public Meeting	X						X																X						Plymouth resident. Fully supports bridge replacement idea. Worried about lane width, lack of a shoulder, and median size. Voiced concerns over the idea of support piers being in the water, and the hazard of a boat accident into them. Worried about the aesthetics not matching the area, stated that something simple would look great.
80		Yes		Written																												X	Can I have a copy of the full draft? (Spoke with Beth) Written on registration card.
81		Yes	10/21/2019	Public Meeting					X												X								X	X		X	Local abutter on the Cape side. Worries about the closing of exit 1, and how that may end up closing his business. Claims he supports 50 jobs, so closure will cause others to lose their jobs. Explained local merchants have not been informed. Emphasizes the fact that he would like improved outreach about project. Frustrated with the process so far, and also worries about the traffic on the Cape.
82		Yes	10/22/2019	Public Meeting	X					X							X																Orleans resident. Is in favor of the replacement of the bridges. Worries about the current bridges beimg historic properties, wonders if they could be turned into pedestrian bridges. Thinks that public parks/places would be a good spot for pieces of the bridges, and could be art installations to preserve the history.
83		No	10/22/2019	Public Meeting					X		X										X						X						South Dennis resident. States the problems the bridges create grow bigger every day and need to be cured. Worries about where the new larger bridges will connect to the existing roads, and worries about traffic. States that the only way to relieve the area of traffic issues is to "go above". Claims the highways should be flyovers on both bridges, briging traffic that is trying to get further down the Cape there quicker. Stated her embarassment for the people who use the bridges daily and their lack of representation at these public forums. Says the bridges are unsafe.
84		Yes	10/22/2019	Public Meeting																	X							X	X				Chatham resident. The EA is not an EIS, and EA is supposed to look at the effects on the human environment, which includes not only the natural environment, but also the social, economic, and the fiscal environment, including the built environment, meaning roads, bridges, and wastewater treatment plants and things like that. The EA states there will be no substantial increase in the number of visitors from these bridges that will be three times as wide as they currently are, but there is no data or analysis to back up this statement. So if 50% more people can go over the bridges during peak summer season, then its disingenuous to support a finding of no signficant impact, and therefore an EIS is justified. Attends all the meetings MassDOT has been hosting, and relays the information to the outer cape. States that people on the outer and lower Cape are unaware of the ongoing MassDOT and USACE work, including town planners. Exclaims the outer and lower Cape will certainly have increased traffic, but there are no numbers to support that in the Evironmental Assessment. Thinks the additional lane width will allow 50% more people to come onto the Cape. Questions which towns specifically have been reached out to. Asks the USACE to extend the comment period another 30 days.
85	Eastham Chamber	Yes	10/22/2019	Public Meeting	X												X																Reads a prepared statement from The Fix Coalition. Explains that the Fix the Bridges Coalition supports the replacement. Stated they wished for the preservation of the canal.

TABLE OF PUBLIC COMMENTS FOLLOWING DRAFT MRER/EA PUBLICATION

					Comment Subject																												
					ALTERNATIVES							ENVIRONMENTAL CONCERNS									TRANSPORTATION					OTHER							
Comment #	Affiliation	Add to Mailing List (Yes/No)	Comment Date	Comment Type	Favor Replacement	Third Bridge	Tunnel	Fill Canal	MassDOT Alternatives	USACE Alternatives	Design Recommendations	Water Quality	T&E Species	Fisheries	Flood Zones/Flooding	Climate Change	Historical/Cultural Concerns	Recreation	Noise/Air Quality	Socioeconomics	Traffic Concerns	Transportation Technology	Tolls	Weight Restrictions/ Concerns	Marine Transportation Considerations	Evacuation Concerns	Safety Concerns	EIS / NEPA Process	Public Involvement/ Communication Concerns	Impacts to Private Property	Timeline of Project	Other	Specific Comments/Questions
86	Town of Eastham	No	10/22/2019	Public Meeting	X																												Eastham chair. Explains that word is making its way to the lower/outer Cape. States that Eastham Community/Municipal officials heard about the project. Is excietd to be involved.
87		No	10/22/2019	Public Meeting	X																										X		Curious about what the timeline is for construction, when will it begin. Supports the estimated start time of 2025.
88		No	10/18/2019	Email							X										X												Would like the new bridges to have five lanes, with the center lane being used or peak traffic allowing for the more congested direction of travel to use it.
89		Yes	10/17/2019	Website																												X	Aside from the safety factor, why do the bridges need to be widened? Will they feed into two lane roads as they do now? If so, what is the benefit?
90		Yes	10/17/2019	Website	X						X										X												It is well past the time when the bridges should be replaced with spans that can accommodate at least some of the traffic being experienced currently. Currently the bridges are inadequate.
91		Yes	10/17/2019	Website	X				X	X	X														X				X	X			After attending the first public forum at Bourne High, it became painfully apparent that the rigid process being used serves as a mechanism to ignore the direct impact on private citizens and property owners impacted in the zones the new bridges would be constructed. The concerns these individuals raised were, essentially, claimed to be irrelevant during the decision phase and that the individuals would be incorporated in the discussion during the design phase. The process will only include their concerns once it has been decided that the bridges are going to be built, which then means the discussion with these individuals is now merely about how it impacts them, not about whether the impact on them could've been prevented in the first place. I agree that the bridges need replacement. The decision making process should weigh the long-term and short-term impacts of various scenarios and favor a plan which may incur short-term pain if it means lesser long-term impacts. The current plan that is being promoted (the largest of the options) will provide two fantasic bridges up to modern standards but they absolutely will impact private land owners surrounding the bridges some of whom have owned these waterfront properties for generations. It seems plausible that you could construct one or two low temporary bridges with just enough clearance to allow most small to medium sized pleasure craft and small commercial vessels (fishing boats etc) to pass underneath. Larger commercial traffic would need to divert around Cape Cod for the duration of construction. Once the temporary bridge(s) are open the current bridges could be torn down and replaced inside their current footprint preventing the need to impact adjacent private land owners or surface road re-routing. In this scenario the primary pain point would impact commercial shipping traffic on a temporary basis for a few years while the bridges are replaced in-place. Traffic would be impacted as traffic would need to route to the temporary bridges, but we would still have two open bridges at all times. This incurs some short-term pain but once completed it has the least land-owner & existing infrastructure/surface roads impacts.
92		Yes	10/17/2019	Website							X																						Please consider flexible lanes that change with traffic needs. Need more than two lanes at height of traffic. Don't take away our Market Basket!
93		Yes	10/17/2019	Website																									X	X			I am officially notifying you that Church lane is owned by Weldon Park residence and not the town of Bourne. We should be notified of any MassDOT design that includes adversely impacting our properties or roads. Any design that includes impacting the property values of any of our community residents is unacceptable. We would appreciate being included/invited to any discussion either publicly or one on one in connection with this issue.
94		Yes	10/17/2019	Website	X				X		X																						I think that the new bridges are necessary but they do not need to include both a sidewalk and bike lane. One or the other.

TABLE OF PUBLIC COMMENTS FOLLOWING DRAFT MRER/EA PUBLICATION

Comment #	Affiliation	Add to Mailing List (Yes/No)	Comment Date	Comment Type	Comment Subject																												Specific Comments/Questions
					ALTERNATIVES							ENVIRONMENTAL CONCERNS									TRANSPORTATION					OTHER							
					Favor Replacement	Third Bridge	Tunnel	Fill Canal	MassDOT Alternatives	USACE Alternatives	Design Recommendations	Water Quality	T&E Species	Fisheries	Flood Zones/Flooding	Climate Change	Historical/Cultural Concerns	Recreation	Noise/Air Quality	Socioeconomics	Traffic Concerns	Transportation Technology	Tolls	Weight Restrictions/ Concerns	Marine Transportation Considerations	Evacuation Concerns	Safety Concerns	EIS / NEPA Process	Public Involvement/ Communication Concerns	Impacts to Private Property	Timeline of Project	Other	
95		No	10/17/2019	Website	X				X		X																						Yes, we need new bridges, however we don't need sidewalks and bike ways. Let's keep it simple. Do only what's necessary not what takes more time, space, and money. One extra lane for pedestrians only.
96		Yes	10/17/2019	Website					X		X										X	X											I am a resident of Sagamore Beach, MA (2 miles from the North side of bridge. I would like to add that more public transportation should always be considered with new transportation plans. Now, with projections of an increase of 42% car traffic to Cape Cod, we just keep thinking of auto traffic. I understand the bridge needs to be demolished and rebuilt, but where is there a recommendation for a continuous train line from south of bridge to Boston? The MBTA has summer service at selected times from S Station to Buzzards Bay, but then a bus. Buses still need to use our roads and have to contend with congestion. I saw a proposed "flyover" for exit 1C on south side of bridge. Is there a similar flyover for exit 2 Cedarville? If so, please let me know as I will put my home up for sale.
97		Yes	10/17/2019	Website															X											X			I live near market basket on louis ave in bourne. I am trying to figure out if my house will be required land for these new bridges. If not I will have construction and a lot of noise in my backyard literally the rest of my life. Please tell me what land will be needed. Thank you
98		Yes	10/17/2019	Website	X		X		X	X	X										X												I was at the meeting last night (16 October) and appreciate the thorough report. My recommendations are that both bridges be replaced but I would make it a 3-lane bridge each way plus a breakdown lane for both bridges. Obviously MassDOT will need to fix infrastructure of roads both on mainland and on Cape Cod. I think using some of land at joint base Otis to redirect roads off the Bourne Bridge would be advisable. Traffic congestion won\'t be fixed with a two-lane bridge each way with a separate lane used for breakdown ... that still provides only two lanes of traffic each way. We all know the congestion and I think a minimum of 3 standard each direction is minimum needed. Also no feeding into rotaries needs to be devised. I also think a tunnel from Exit 4 on Route 3 (Manomet area) under Cape Cod Bay connecting to mid-Cape highway around Exit 6 would take pressure off bridges as well. Most of tourism coming down Route 3 heads to Exit 6 or higher and why not divert traffic that way. It would ease congestion for year-round residents many who commute up the South Shore and to Boston.
99		Yes	10/18/2019	Website					X												X												I hope the Corp and the DoT will look not just at the bridges but also the totality of Route 6. The delays getting on and off the Cape are 70% the bridges but 30% Route 6. Rt 6 needs to be expanded all the way down Cape. Where it is two lanes it needs to be four. Rt 6 should also be at least three lanes wide all the way to Hyannis.

TABLE OF PUBLIC COMMENTS FOLLOWING DRAFT MRER/EA PUBLICATION

Comment #	Affiliation	Add to Mailing List (Yes/No)	Comment Date	Comment Type	Comment Subject																												Specific Comments/Questions
					ALTERNATIVES							ENVIRONMENTAL CONCERNS									TRANSPORTATION					OTHER							
					Favor Replacement	Third Bridge	Tunnel	Fill Canal	MassDOT Alternatives	USACE Alternatives	Design Recommendations	Water Quality	T&E Species	Fisheries	Flood Zones/Flooding	Climate Change	Historical/Cultural Concerns	Recreation	Noise/Air Quality	Socioeconomics	Traffic Concerns	Transportation Technology	Tolls	Weight Restrictions/ Concerns	Marine Transportation Considerations	Evacuation Concerns	Safety Concerns	EIS / NEPA Process	Public Involvement/ Communication Concerns	Impacts to Private Property	Timeline of Project	Other	
100		Yes	10/18/2019	Website			X				X										X		X										My wife (Shelagh Joyce, Plymouth Selectwoman) and I attended the presentation MRER last evening at Plymouth South HS. We along with maybe 25 other attendees listen & watched the outstanding program concerning these two bridges. The meeting was professionally done & it was obvious much went into this hearing. We both were very disappointed in the turnout. Years of preparation and when it comes down to actually making a decision in which direction to pursue where were the residents and businesses to air their concerns? They will have NOBODY to blame but themselves if this project doesn't go as "they" want. We believe that the fourth alternative is the best solution. Although 3 lanes in each direction (one an on/off lane) will certainly be an improvement from what's there now this is not enough. Unfortunately this like the Big Dig will be outdated quickly. Build for the future not for today! There should be at least 4 lanes in each direction with 3 travel lanes. Merging into 2 does cause a problem but if the breakdown lane south is made into a slip ramp for at least a half mile or so that merge could be minimized. Same with the north side. This project will take over 3 years to complete and through 2025 will cause much havoc but must be done. Let's do it right and good for the next 50 years (maybe 84 years)! To help with future traffic a tunnel (shall I call it a chunnel?) from the Plymouth area to Provincetown should be explored. Progressive thinking to possibly make this happen in the next 25 years would bring about 40% of that traffic from the other direction. ! Would think Plymouth might want that possible toll revenue also? My estimate at the present volumes could be as much as $10 million annually!
101		Yes	10/19/2019	Website	X																											X	I am in full support of replacing both bridges, my comment is more in the aftermath. After these new bridges are built I think buffer zones need to be implemented to prevent any buildings from being built under or around. We need to be forward thinking and if 50-100 years from now citizens or businesses will just be uprooted again it will be the same mess. Take the current lands where roads are now and take the areas for the new bridges and that way the bridges can be replaced on land already owned by the government.
102		Yes	10/19/2019	Website																										X			Alternative D makes the most sense - when will we know about the impact on nearby existing homes/businesses with the bridges?
103		Yes	10/19/2019	Website	X														X		X					X							I do not see how repairing the bridges is a viable plan. Repairs have been done every year, causing disruption to commuters and businesses doing work on the Cape. In the summer, traffic on the current bridges is a deterrent to tourism, and the long delays cause unnecessary carbon emissions. The bridges are extremely old. Fifty of the regions bridges including the Bourne Bridge and Sagamore Bridge fall into the functionally obsolete category, according to the federal Highway Administrations National Bridge Inventory. Also, the current bridges impede swift evacuation of Cape residents, in the event of an extreme weather event or problem with the decommissioning of the Pilgrim nuclear power plant. New bridges, built in parallel to the existing bridges, is the best, safest and least disruptive plan.
104		Yes	10/20/2019	Website																										X			Please post residents whose homes and businesses will be affected
105		Yes	10/20/2019	Website																X										X		X	We have several properties that will be affected including our business and the business that we rent to. We will have major loss of income and will we compensated for this.?Since this information has come out our tenants will be looking to move and loss of rent could bankrupt us. Do you pay for attorney fees? Who is the entity that determines fair market value?
106		No	10/20/2019	Website			X																										The tunnel. 26 miles across the ocean in Europe . I think we could handle and afford the small spanse involved in our project. (One of course, would be residents only!!)

TABLE OF PUBLIC COMMENTS FOLLOWING DRAFT MRER/EA PUBLICATION

Comment #	Affiliation	Add to Mailing List (Yes/No)	Comment Date	Comment Type	Comment Subject																												Specific Comments/Questions
					ALTERNATIVES							ENVIRONMENTAL CONCERNS									TRANSPORTATION					OTHER							
					Favor Replacement	Third Bridge	Tunnel	Fill Canal	MassDOT Alternatives	USACE Alternatives	Design Recommendations	Water Quality	T&E Species	Fisheries	Flood Zones/Flooding	Climate Change	Historical/Cultural Concerns	Recreation	Noise/Air Quality	Socioeconomics	Traffic Concerns	Transportation Technology	Tolls	Weight Restrictions/ Concerns	Marine Transportation Considerations	Evacuation Concerns	Safety Concerns	EIS / NEPA Process	Public Involvement/ Communication Concerns	Impacts to Private Property	Timeline of Project	Other	
107		Yes	10/22/2019	Website	X					X																							ACCELERATED bridge replacement
108		No	10/22/2019	Website						X	X										X												Why are you not looking at the obvious - stop the developers from overbuilding the Cape or in your case don't make accommodations so they keep over developing. The more the population keeps growing and growing from over-developing will you keep on building bigger bridges just because there is traffic on the bridges?? If your answer is 'no of course not'. Then why are you trying to build a so called mega bridges now - it's the same thing. I grew up on the Cape and in my lifetime I've seen how it's changed and not for the better with all the crowds. If the current bridges are in need of such extreme repair then just replace the bridge with the same design and same number of lanes, just update the width. Why do you think you need to make such drastic changes to accommodate more people/cars. The bridges are not the cause of the traffic on the Cape, over development is. So I don't understand the thought process of making new giant bridges to then be in the same traffic and crowds once you cross them in the little towns on the Cape.
109		Yes	10/22/2019	Website																	X												How will the proposed new bridges impact an increase in the numbers of vehicles/traffics on the Cape.
110		No	10/23/2019	Website	X																												Replace them.
111		No	10/23/2019	Website	X																X												I live one mile from the Sagamore Bridge. The current bridge traffic frequently backs up into my neighborhood making my life miserable. Can't get out to the store, doctors appts etc. I fully support the new 4 lane bridges being proposed and feel they are the best plan for Cape Codders and visitors alike.
112		Yes	10/23/2019	Website																										X			I presently live on Sir Lancelot Dr in Weldon Park in Bourne. I live next to Rte 3. I have concerns about Eminent domaine as I believe home owners are given the fair market value. Yet with the impending impact on my property and others the fmv will be less. I am newly divorced, 64 years old and can not look to financial despair do to these changes made by others.
113	President, CEO Cape Cod Canal Region Chamber of Commerce	Yes	10/15/2019	Written	X																										X		Support the replacement. The timeline set is supported. The project cannot be delayed, these bridges are the lifelines for the Cape & Islands.
114		Yes	10/7/2019	Written	X	X			X	X	X										X	X					X						Supports replacement. Third bridge would helo cut down traffic. Train bridges should be built to accommodate from Boston to the Cape. A separate bike/pedestrian bridge should be built. These should be inspected every 2 years to ensure safety.
115		Yes	10/18/2019	Email							X										X												The traffic with these new enhanced bridges will congest the Cape further down. The additional third lane on each bridge would just increase the amount of traffic on the local roads down on the Cape. There is no room for traffic on the already congested roads. 2 lanes each way, with a walking/biking lane is a suggestion.
116	Town of Bourne, Assistant Town Administrator	Yes	10/21/2019	Written	X																												Town of Bourne supports replacement.
117		Yes	10/23/2019	Public Meeting	X						X																						Stated that he enjoyed reading the draft. Explained he hopes that the new bridges will have a unique design like the current ones do. Expressed he would like to see a pedestrian walkway elevated up over the center median as it would reduce possibility of accidents to the pedestrians.

TABLE OF PUBLIC COMMENTS FOLLOWING DRAFT MRER/EA PUBLICATION

					Comment Subject																												
					ALTERNATIVES							ENVIRONMENTAL CONCERNS									TRANSPORTATION					OTHER							
Comment #	Affiliation	Add to Mailing List (Yes/No)	Comment Date	Comment Type	Favor Replacement	Third Bridge	Tunnel	Fill Canal	MassDOT Alternatives	USACE Alternatives	Design Recommendations	Water Quality	T&E Species	Fisheries	Flood Zones/Flooding	Climate Change	Historical/Cultural Concerns	Recreation	Noise/Air Quality	Socioeconomics	Traffic Concerns	Transportation Technology	Tolls	Weight Restrictions/ Concerns	Marine Transportation Considerations	Evacuation Concerns	Safety Concerns	EIS / NEPA Process	Public Involvement/ Communication Concerns	Impacts to Private Property	Timeline of Project	Other	Specific Comments/Questions
118		Yes	10/23/2019	Public Meeting	X				X																								Explained the collaboration between MassDOT and USACE is great. Expressed the political side of the process should begin now, so they are not waiting for papers in the long run. Stated there is no need for rotaries anymore, and that the roadways need to match the bridges and be updated.
119		No	10/23/2019	Public Meeting																	X							X				X	Explained he used to write environmental assessments for the federal government. Stated the traffic volumes for MassDOT were made available on the Monday prior to the meeting, so he has not had the chance to search through the 852-page document to retrieve numbers based on traffic volume projections further down the Cape. Further stated that the cars coming over the Cape end up somewhere. Requested someone from MassDOT pull up the numbers he is looking for. Further questioned how many more people will be coming over the bridge during the peak months. Asked again if anyone from MassDOT would be able to give him the numbers he is looking for. Stated again that the Environmental Assessment says it is not likely that the new bridges will increase the number of people/cars on the Cape, which he believes is quite a stretch if the replacement bridges will allow 25% more cars over them than the existing bridges. Expressed his concern about the speed of development and increased number of people on the Cape as a result of the new bridges being easier to travel over.
120		No	10/23/2019	Public Meeting	X																											X	Stated he applauds the effort and wants the process to be as quick as possible. Explained that as a member of the Cape Cod Cycling Club he loved the designated lane for bikes and pedestrians that has been shown in the design process for the new bridges.
121		Yes	10/23/2019	Public Meeting	X						X		X																	X			Expressed gratitude towards the USACE for going through with the study. Would like to see the new bridges be designed in a way with open sides so passengers in cars can admire the canal. Expressed her want for the local merchants and business owners that abut the bridges construction to have their livelihood protected. Explained her wish that peoples houses would be protected at all costs. Wondered if there would be any disruption to the fish and sea life in the canal.
122		Yes	10/23/2019	Public Meeting					X	X																						X	Explained that there needs to be consideration given to the residents of Bourne when it comes to canal transportation. Stated that due to the town being divided, school, EMS and other essentials may be across the canal from people with no access to them.
123		No	10/23/2019	Public Meeting	X																						X						Stated the replacement is long overdue. Expressed his concerns over bridge failure, that it would cause the Cape to starve, and medical supplies would be low. Questioned how the estimates were modeled.
124	Local 385	Yes	10/23/2019	Public Meeting	X																						X						Expressed his gratitude to the USACE for keeping the bridges maintained all these years. Emphasized safety throughout the process.
125		Yes	10/23/2019	Public Meeting																			X										Questioned if tolls were a possibility on the new bridges, and the process that goes into making a roadway able to be tolled.
126		Yes	10/23/2019	Written																			X										No tolls please, maintain control of the bridges and all bridges in Massachusetts.
127		Yes	10/23/2019	Website																	X				X							X	Would be nice to have some kind of water Taxi/Boat Taxi/ferries from Plymouth Harbor or others for Transportations to Cape Cod while the bridges are in works to avoid traffic & delays. This would add the revenues. Just like we have ferries to islands.
128	Cape Cod Technology Council	Yes	10/23/2019	Website	X																												The CCTC supports the MRER recommendation that providing two new highway bridges would be the most effective means of providing safe and reliable crossings. The CCTC supports the expeditious implementation of the MRER recommendation.
129	Private Citizen	No	10/24/2019	Website			X																										Has anyone considered a tunnel which would allow the bridges to be deconstructed and removed from traffic flow.

TABLE OF PUBLIC COMMENTS FOLLOWING DRAFT MRER/EA PUBLICATION

Comment #	Affiliation	Add to Mailing List (Yes/No)	Comment Date	Comment Type	Comment Subject																												Specific Comments/Questions
					ALTERNATIVES							ENVIRONMENTAL CONCERNS									TRANSPORTATION					OTHER							
					Favor Replacement	Third Bridge	Tunnel	Fill Canal	MassDOT Alternatives	USACE Alternatives	Design Recommendations	Water Quality	T&E Species	Fisheries	Flood Zones/Flooding	Climate Change	Historical/Cultural Concerns	Recreation	Noise/Air Quality	Socioeconomics	Traffic Concerns	Transportation Technology	Tolls	Weight Restrictions/ Concerns	Marine Transportation Considerations	Evacuation Concerns	Safety Concerns	EIS / NEPA Process	Public Involvement/ Communication Concerns	Impacts to Private Property	Timeline of Project	Other	
130	Private Citizen	Yes	10/24/2019	Website							X																						Please make the final design feel like it belongs in the environment, and does not look like the "trendy" Zakim Bridge style.
131	Private Citizen	Yes	10/24/2019	Website						X																							I think you should renovate and not rebuild. Those bridges were built when quality mattered and why they have lasted this long.
132	Private Citizen	Yes	10/24/2019	Website					X																								Exit 2 should be replaced with a "diamond" shape exit/entrance configuration. The current intersection appears very dangerous when traveling eastbound on US 6 exiting to SH 130. The curve is too sharp and doesn't appear until drivers are in the intersection.
133	Private Citizen	Yes	10/26/2019	Website	X															X	X		X						X	X			For safety and economic reasons, I support Alternative D- the complete replacement of both bridges with new construction of four lanes plus two auxiliary lanes. The replacement of these bridges is vital to local economic development. Concerned about how the project will be funded. I strongly urge the Army Corp to design the new bridges to minimize the impacts on nearby homeowners.
134	Private Citizen	Yes	10/27/2019	Website																												X	Please drop hard copy at Gallo office
135	Private Citizen	Yes	10/27/2019	Website	X				X											X													I am concerned that the east side of Wareham will ultimately become a ghost town. I do feel the bridges should be rebuilt but Is there any way to make sure that the re-routing of access roads to the bridges do not impact an already depleted economy in East Wareham? Please reply.
136	Private Citizen	Yes	10/27/2019	Website	X																X												I whole heartedly back the building of two brand new bridges to connect Cape Cod to the mainland. We cannot keep being held hostage by failing bridges that need painting and refurbishing every few months. It makes the traffic on these bridges unbearable.
137	Private Citizen	Yes	10/28/2019	Website	X					X	X							X															Upgrading bridges is a real need, hope new expanded size helps but doesn't make Rt 6 traffic more congested. Walkway over the Hudson in Poughkeepsie NY is a old railroad bridge conversion to a pedestrian walk and is a huge tourist destination. Maybe one of the canal bridges could be a pedestrian/bike way. and eliminate that aspect on the new bridge.
138	Private Citizen	Yes	10/28/2019	Website			X														X												I have seen in the past that the cost of maintaining our present bridges over the last 86 years has been going up each year. Not to mention the inconvenience to drivers during lane closures during maintenance operations. I would think that building a pair of tunnels would be more cost effective and require less annual maintenance than building a pair of new bridges.
139	Private Citizen	Yes	10/29/2019	Website						X	X			X				X							X								I fully support building two new bridges. However, if large ships no longer need to traverse the canal, then lower cost bridges, such as causeway or lower suspension bridge on pilings should be considered. I am an avid recreational fisherman, so I do not support filling in the canal or narrowing the bridge opening by filling in on either side.
140	Private Citizen	Yes	10/29/2019	Website	X				X		X										X												Please do not make replacement bridges too big. It will just push bottlenecks somewhere else. At present people leaving the Cape via the Bourne Bridge are often blocked by vehicles arriving over the bridge and clogging the Bourne Rotary in order to get to Rt. 6, 6A and points along the Canal. A bigger bridge will allow more traffic and potentially worsen this problem; a redesigned rotary will potentially ease it.

TABLE OF PUBLIC COMMENTS FOLLOWING DRAFT MRER/EA PUBLICATION

Comment #	Affiliation	Add to Mailing List (Yes/No)	Comment Date	Comment Type	Comment Subject																												Specific Comments/Questions
					ALTERNATIVES							ENVIRONMENTAL CONCERNS									TRANSPORTATION					OTHER							
					Favor Replacement	Third Bridge	Tunnel	Fill Canal	MassDOT Alternatives	USACE Alternatives	Design Recommendations	Water Quality	T&E Species	Fisheries	Flood Zones/Flooding	Climate Change	Historical/Cultural Concerns	Recreation	Noise/Air Quality	Socioeconomics	Traffic Concerns	Transportation Technology	Tolls	Weight Restrictions/ Concerns	Marine Transportation Considerations	Evacuation Concerns	Safety Concerns	EIS / NEPA Process	Public Involvement/ Communication Concerns	Impacts to Private Property	Timeline of Project	Other	
141	Private Citizen	Yes	10/29/2019	Website												X						X											This is an extremely important initiative and concerns about safety and traffic well addressed. Unfortunately, there seems to be a serious oversight that has ignored the future needs for non-petroleum based transport and better public transport. This will be crucial to the Cape and all of New England and I ask that the study be revised to include a really serious look at such options. Given our current issues with fossil fuel environmental impacts, finite supplies, projected costs (without public subsidies), population trends, and economic alternative technologies with renewable energy for public rail and bus service I believe it is irresponsible to ignore these options. Improved and bigger bridges might be part of the solution but we must consider what we know to be true, transportation has to move away from cars and trucks towards more efficient & economic systems.
142	Private Citizen	Yes	10/29/2019	Website	X				X	X	X									X										X		X	There are several references to the State which should be Commonwealth. The reference bridge is missing the dimension for the median and the side parapets. It is also not listing the height of the ending reference piers. I suggest that the design use a double-decker concept. This will minimize the amount of land takings. I also suggest that an underpass be considered between Market Basket and Christmas Tree shop. There needs to be a study performed on the economic impact of the dead ending of Cranberry Highway. I do support the implementation of a new bridge. I do think that the Commonwealth consider adding funds to add a fourth lane in each direction. The bridge should not be the constriction, the Commonwealth should determine that with the access roads.
143	Private Citizen	Yes	10/30/2019	Email						X						X						X											Oppose the construction of new, larger bridges to replace the aging Bourne and Sagamore bridges to Cape Cod. We believe Cape Cod and our grandchildren are better served by using a fraction of the $1 billion estimated cost to instead improve public and rail transportation for Cape Cod residents and visitors. Climate change is largely driven by fossil fuel pollution, and we know from hundreds of past experiences that larger bridges merely stimulate more driving and more pollution. We must break out of obsolete thinking and wasteful policies. We have a once-in-a-lifetime opportunity to be more intelligent than we were in the past. We can be more frugal and cost-effective with a huge outlay of public money, providing better options for a fraction of the cost of the new, larger bridges. We can provide a modern solution to the deteriorating bridges, rather than trying to make outdated answers fit.
144	Private Citizen	Yes	10/24/2019	Public Meeting																												X	I would like to be updated as often as possible about the bridge rehab.
145	Chairman, Board of Selectmen Town of Bourne	Yes	10/23/2019	Written	X								X	X	X	X	X	X	X	X							X		X	X	X	X	We request that the Army Corps, and MassDOT join the Bourne Board of Selectmen in public session to start to work out the public engagement schedule with the various stakeholders (residents, businesses, emergency response, schools, etc) and plans for moving forward in more detail. May I suggest Tuesday, December 3, 2019 as a possible meeting? The Town of Bourne is most interested in: Safety — including hazardous waste; Residential challenges; Environmental concerns; Land acquisition; Economic impact; Coordination and dissemination of Army Corps and MassDOT planning; Timing, implementation, and public communication; Restoration of disrupted areas; as well as many more topics.

TABLE OF PUBLIC COMMENTS FOLLOWING DRAFT MRER/EA PUBLICATION

Comment #	Affiliation	Add to Mailing List (Yes/No)	Comment Date	Comment Type	Comment Subject																												Specific Comments/Questions
					ALTERNATIVES							ENVIRONMENTAL CONCERNS									TRANSPORTATION					OTHER							
					Favor Replacement	Third Bridge	Tunnel	Fill Canal	MassDOT Alternatives	USACE Alternatives	Design Recommendations	Water Quality	T&E Species	Fisheries	Flood Zones/Flooding	Climate Change	Historical/Cultural Concerns	Recreation	Noise/Air Quality	Socioeconomics	Traffic Concerns	Transportation Technology	Tolls	Weight Restrictions/ Concerns	Marine Transportation Considerations	Evacuation Concerns	Safety Concerns	EIS / NEPA Process	Public Involvement/ Communication Concerns	Impacts to Private Property	Timeline of Project	Other	
146	President, Cape Cod Synagogue Men's Club	No	10/24/2019	Written																	X											X	Regrettably, I was unable to attend last evening's presentation at Barnstable High School. I did want to introduce myself to you with the hope of having you be the speaker at a meeting of the Cape Cod Synagogue Men's Club. The subject of the status of the existing structures and the potential for modernization and improvement to 2025 standards is really relevant Cape Wide. Many within our congregation have school-age children, travel off-Cape daily for work, or are retirees who are very active travelling frequently on- and off-Cape. Many of these trips are based upon and restricted to time commitments. Our next program will be scheduled for a Sunday in January, 2020. Please contact me at (508) 394-6644 to plan a date that fits into both of our schedules.
147	Private Citizen	Yes	10/30/2019	Website							X										X	X											Strongly urge adding a public transportation solution in the bridge replacement design. As a full time resident who needs to frequently travel to Boston and Fall River for work, I have witnessed the rush hour traffic going on and off the Cape increase over the past 10 years. Overall a public transportation option could help full time commuters and day trippers to the Cape as well as helping reduce the environmental impact of car emissions.
148	Private Citizen	Yes	10/30/2019	Website							X					X					X	X										X	To move into our future with respect to transportation and climate survival it is imperative we include 1) bicycle lanes 2) separate pedestrian lanes, 3) BUS lanes 4) YES, RAIL on the new bridges as the existing will be also be replacement eligible in the immediate future TO BE CLEAR WE NEED TO MOVE AWAY FROM THE OIL DEPENDENT LIFESTYLE OF THE LAST CENTURY AND MOVE INTO THE PRESENT AND FUTURE SUPPORT MULTI TRAVEL BRIDGE-LANES
149	Private Citizen	Yes	10/30/2019	Website							X										X	X											Concerned that making wider access to the Cape will bring more people and there\'s no room. Route 6A in the summer is bumper to bumper with cars in the afternoon, so the idea of bringing more tourists to the Cape is not sustainable. The roads on Cape are clogged. The traffic at the bridges currently serves to limit/discourage and i think that is necessary. Also, where\'s the public transportation???? Can we make a faster train connection to Boston, or a dedicated bus lane? We SHOULD NOT be designing for car traffic only!
150	Private Citizen	Yes	10/30/2019	Website								X				X		X			X	X											Environmental impact of this should be taken into account. Creating larger bridges will increase driving (a huge problem in the greater scheme of climate change) and increase visitors to the Cape when many places are already at carrying capacity. If the bridges need to be replaced they should be of comparable size and access. The Cape is a special place because of limited access. Does anyone really want their beaches and natural areas to be more crowded than they already are? Do we want to encourage more development near natural resources that are already at capacity? Look at the report for water quality on Cape Cod-- our bays are of unacceptable water quality. Adding more people into the mix will aggravate this problem. If the bridges need to be replaced, keep them the same size.

TABLE OF PUBLIC COMMENTS FOLLOWING DRAFT MRER/EA PUBLICATION

Comment #	Affiliation	Add to Mailing List (Yes/No)	Comment Date	Comment Type	Comment Subject																												Specific Comments/Questions
					ALTERNATIVES							ENVIRONMENTAL CONCERNS									TRANSPORTATION					OTHER							
					Favor Replacement	Third Bridge	Tunnel	Fill Canal	MassDOT Alternatives	USACE Alternatives	Design Recommendations	Water Quality	T&E Species	Fisheries	Flood Zones/Flooding	Climate Change	Historical/Cultural Concerns	Recreation	Noise/Air Quality	Socioeconomics	Traffic Concerns	Transportation Technology	Tolls	Weight Restrictions/ Concerns	Marine Transportation Considerations	Evacuation Concerns	Safety Concerns	EIS / NEPA Process	Public Involvement/ Communication Concerns	Impacts to Private Property	Timeline of Project	Other	
151	Private Citizen	Yes	10/30/2019	Website							X				X	X					X	X	X										If the bridges need to be replaced it should be done with a mindfulness to easing flow as well as reducing emissions. The train and bus usability should be increased. To encourage this there should be a toll per car going over but no added fee for taking the bus or train. Maybe smaller van services can make a helpful schedule from Hyannis where the busses drop off so you can get further out. Its worth considering reducing the traffic or much of these future visitors will be visiting a swamp anyway with ocean levels rising.
152	Private Citizen	No	10/30/2019	Website					X		X					X		X		X	X	X											Allow for future improvements to public transportation networks on and to/from the Cape when evaluating options for moving forward. In addition to carbon footprint and emissions issues related to all the visitors arriving by car, there is a significant lack of usable public transit options for both visitors and locals on cape. The study seems to address impacts to existing bus traffic, but not potential for supporting more transit use across the canal. If the bridges are to be potentially redesigned and rebuilt, consider the potential benefits of options like incorporating bus and carpool lanes, safe bike lanes, infrastructure that would enable more arrivals by train, or any other solutions that may support a reduced number of cars driving to and from the Cape while still allowing for flow of traffic and a strong tourist economy. And, that they will consider the costs of continued reliance primarily on cars for travel across the canal. The Cape is a unique and fragile place, more susceptible to climate change and more dependent on its natural resources than most - this is an important opportunity to make positive changes that will help ensure this landscape and its communities can thrive in the future.
153	Private Citizen	Yes	10/30/2019	Website					X	X						X					X	X											Oppose building larger bridges and making auto travel (pollution) easier. We must confront climate change, rather than ignore it and pass the costs on to our grandchildren. I support using a fraction of the $1 billion cost of new bridges for better public transportation and rail connections.
154	Private Citizen	Yes	10/30/2019	Website					X	X						X					X	X											Maintain or rebuild the canal bridges with no additional vehicle lanes. More lanes will induce more trips, net vehicle emissions and congestion on the Cape's roadways and waterways. Rather than adding vehicle lanes on either bridge, pursue improving public mass rail and bus transportation infrastructure.
155	Private Citizen	Yes	10/30/2019	Website							X										X	X											Essential part of new bridge to the Cape and Islands should support public transportation, including trains tracks and bike lanes. We need to get people out of cars! Making it easier to drive to the Cape will only contribute to the already overburdened and abused natural resources. One of the main reasons people travel here is to enjoy the natural beauty and serenity. This is the perfect opportunity to show that we are serious about preserving what we have left by de-incentivizing car travel. Please plan for a cleaner, healthier future for the next generations and include mass transportation in the bridge plans.

TABLE OF PUBLIC COMMENTS FOLLOWING DRAFT MRER/EA PUBLICATION

					Comment Subject																												
					ALTERNATIVES							ENVIRONMENTAL CONCERNS									TRANSPORTATION					OTHER							
Comment #	Affiliation	Add to Mailing List (Yes/No)	Comment Date	Comment Type	Favor Replacement	Third Bridge	Tunnel	Fill Canal	MassDOT Alternatives	USACE Alternatives	Design Recommendations	Water Quality	T&E Species	Fisheries	Flood Zones/Flooding	Climate Change	Historical/Cultural Concerns	Recreation	Noise/Air Quality	Socioeconomics	Traffic Concerns	Transportation Technology	Tolls	Weight Restrictions/ Concerns	Marine Transportation Considerations	Evacuation Concerns	Safety Concerns	EIS / NEPA Process	Public Involvement/ Communication Concerns	Impacts to Private Property	Timeline of Project	Other	Specific Comments/Questions
156	Non-Government Organization	Yes	10/30/2019	Website							X											X							X				Request replacement bridges include designated bicycle and pedestrian pathways that are separated by physical barriers from the vehicle lanes. Recommending that the separated pathways be designed to modern standards of pathway, and they should be a pleasant experience to encourage non-motorized transportation. As an example, the pathway on the Whittier Bridge in Amesbury was built 15\' wide with an additional 5\' for overlooks and benches along the route. Benches are important for people who may not be able to walk or bike the whole bridge and need to rest. We also suggest that the planning for the replacement bridges consider the need for connections on either side of the bridges to the Cape Cod Canal pathway system. As we move from planning into the design phase, we would very much appreciate being included as a stakeholder in whatever formal process takes shape (working groups, task forces, and the like).
157	Private Citizen	Yes	10/30/2019	Website							X					X					X	X											Not including mass public transportation options into the new bridge plans is a terrible mistake. The Cape and Massachusetts should be planning on lessening our greenhouse gas emissions. Please take into account future mass transit options and not limit your thinking that the Cape can only be reached by private car transportation and so the only option is to make the bridges wider to accommodate more car traffic.
158	Private Citizen	Yes	10/31/2019	Website												X					X	X											Widening the bridges will bring more cars and congestion. We need to be focused on regional transit systems - like trains from Boston and New York - and a more robust local bus system on the Cape, to move more people with less environmental impact!
159	Private Citizen	Yes	10/31/2019	Website											X					X	X		X										Crucial that this region is preserved for the residents and the future of the coastline. More traffic would increase tourism and contribute to the death of a special place in this beautiful country. I would be more open to the bridges if tolls were added for out of state users. But then again, it would contribute to benefiting the haves and hurting the have nots. Be conservative please.
160	Private Citizen	Yes	10/31/2019	Website																									X	X	X		I need to have an idea about the future of my family and my properties that will be taken by eminent domain.
161	Non-Government Organization	Yes	10/31/2019	Website	X																												In favor of replacement of the Sagamore and Bourne Bridges as an economic necessity and public safety imperative - to ensure safe and efficient travel to and from Cape Cod and improve evacuation routes to the mainland.
162	Non-Government Organization	Yes	10/31/2019	Website	X																												The Coalition supports the replacement of both bridges; with each bridge including four lanes, two auxiliary lanes, one separated lane for pedestrian and bicycle traffic, shoulders, and medians to separate north/south traffic. We appreciate the conceptual design with consideration for sea level rise, reduced deck grade, and standard sized travel lanes. We also support preservation of the Cape Cod Canal itself as a major recreational and marine navigational resource.
163	Private Citizen	Yes	10/31/2019	Website	X						X					X					X	X											Applaud the idea of replacing the Bourne and Sagamore bridges, I disagree with increasing the potential volume of cars that can cross it. Two wider lanes for cars and trucks seems reasonable to me, but after that I would strongly prefer better support for greener forms of transportation such as public transit buses, trains, pedestrian, and bike traffic. Perhaps a lane for public transit and green vehicles would make sense.

TABLE OF PUBLIC COMMENTS FOLLOWING DRAFT MRER/EA PUBLICATION

Comment #	Affiliation	Add to Mailing List (Yes/No)	Comment Date	Comment Type	Comment Subject																												Specific Comments/Questions
					ALTERNATIVES							ENVIRONMENTAL CONCERNS									TRANSPORTATION					OTHER							
					Favor Replacement	Third Bridge	Tunnel	Fill Canal	MassDOT Alternatives	USACE Alternatives	Design Recommendations	Water Quality	T&E Species	Fisheries	Flood Zones/Flooding	Climate Change	Historical/Cultural Concerns	Recreation	Noise/Air Quality	Socioeconomics	Traffic Concerns	Transportation Technology	Tolls	Weight Restrictions/ Concerns	Marine Transportation Considerations	Evacuation Concerns	Safety Concerns	EIS / NEPA Process	Public Involvement/ Communication Concerns	Impacts to Private Property	Timeline of Project	Other	
164	Private Citizen	Yes	10/31/2019	Website	X						X						X	X															Support two new bridges as recommended by the study, but I do not think we should be too hasty in demolishing the existing historic bridges. They are a symbol of the region and the threshold of the Cape. If the new bridges are not finished within 5 years and maintenance must occur, then it stands to reason that the newly refurbished bridges should not be torn down, but instead converted to pedestrian and cyclist traffic and continue to serve for decades to come. If the new bridges are completed on schedule and the existing bridges are torn down. I would hope that pieces of them are saved and distributed along the canal to serve as pavilions, seating, public art installations, and more to ensure that the history of the Cape and the two bridges that connected it for 84 years is not lost.
165	Private Citizen	Yes	10/31/2019	Website			X																										Build tunnels. Pre build sections to submerge in canal. The larger ships (with larger drafts) that use the canal can certainly go around. Maintenance on tunnels has to be easier than bridges.
166	Private Citizen	No	10/31/2019	Website					X		X																						Rebuilding the bridges is a very good idea, but nothing will change unless the state changes the two lane roads leading to and from both bridges.
167	Private Citizen	No	10/31/2019	Website						X											X	X											Please maintain or rebuild the canal bridges with no additional vehicle lanes. More lanes will induce more vehicle trips, more net vehicle emissions and more congestion on Cape and Island roadways and waterways. Rather than increasing the number of vehicle lanes on either bridge, please think ahead about environmental and quality of life sustainability. Pursue the alternatives of improved public rail and bus transportation infrastructure.
168	Private Citizen	Yes	10/31/2019	Website	X																		X										Support the study's Recommended Plan, urge the Corps to place this project on your work plan, allocate the necessary funding to execute and complete the project, work diligently with representative from the Commonwealth of Massachusetts to put in place a timely MOU for ownership and operation of the new bridges by Massachusetts once they are fully functional and to include a binding stipulation that the bridges may never be turned into toll bridges, and, finally, I urge the Corps to include representatives from the Town of Bourne throughout the entire planning, engineering and construction process.
169	Private Citizen	Yes	10/31/2019	Website	X																				X								Canal bridges should permanently remain under the control for replacement and maintenance until the canal is closed to ship/boat traffic
170	Private Citizen	Yes	10/31/2019	Website																					X								Do you know where I could get more information about how much shipping is done through the canal? Hopefully some type of year by year information.
171	Private Citizen	Yes	10/31/2019	Website																												X	I would suggest that rather than increasing access to Cape Cod, that you focus on the problem of sewage treatment which as all studies indicate, is desperately needed on Cape Cod.
172	Private Citizen	Yes	10/31/2019	Website	X																												Fully support the new bridges with the third lane for emergency vehicles. This will be the safest alternative for all concerned now and in the distant future. Thank you for all your efforts.
173	Non-Government Organization	Yes	10/31/2019	Website	X																												Replace those bridges as they are very dated and will last about 20 more years tops. Replace the Sagamore bridge to the East and the borne bridge to the East also.
174	Non-Government Organization	Yes	11/1/2019	Website																												X	The Sierra Club Massachusetts Chapter sent our comments from our Director Deb Pasternak via USPS mail. However here is a copy of it electronically through a PDF on our website. Link is here below: https://www.sierraclub.org/sites/www.sierraclub.org/files/sce/Massachusetts-chapter/MASC_%20Cape%20Cod%20Canal%20Bridges%20Comments%20to%20ACOE%20.pdf

TABLE OF PUBLIC COMMENTS FOLLOWING DRAFT MRER/EA PUBLICATION

Comment #	Affiliation	Add to Mailing List (Yes/No)	Comment Date	Comment Type	Comment Subject																												Specific Comments/Questions
					ALTERNATIVES							ENVIRONMENTAL CONCERNS									TRANSPORTATION					OTHER							
					Favor Replacement	Third Bridge	Tunnel	Fill Canal	MassDOT Alternatives	USACE Alternatives	Design Recommendations	Water Quality	T&E Species	Fisheries	Flood Zones/Flooding	Climate Change	Historical/Cultural Concerns	Recreation	Noise/Air Quality	Socioeconomics	Traffic Concerns	Transportation Technology	Tolls	Weight Restrictions/ Concerns	Marine Transportation Considerations	Evacuation Concerns	Safety Concerns	EIS / NEPA Process	Public Involvement/ Communication Concerns	Impacts to Private Property	Timeline of Project	Other	
175	Private Citizen	Yes	11/1/2019	Website	X																										X		The bridges carry too many people and cargo and need to be completely rebuilt ASAP. Why wait until 2025 to get started? And please do not take multiple years to complete the bridges like the one in Quincy!?!
176	Private Citizen	Yes	11/1/2019	Website	X																		X				X						The current bridges are past their expected lifetimes and pose a serious concern for the safety of all who use them. As the Army Corps of Engineers has proposed, it is also feasible for the bridges to be turned over to the State of Massachusetts for future maintenance. I believe that the considerable future costs of this maintenance should be financed through tolls for all vehicles crossing the bridges.
177	Private Citizen	Yes	11/1/2019	Website													X																Will there be an effort to replicate the iconic look of the current bridges? The profile is so representative of Cape Cod.
178	Private Citizen	Yes	11/1/2019	Website							X										X	X											Widening the two bridges will not solve the Cape's transportation problems, but will only add to them by improving access up to (but not beyond) the Cape side of the bridges. Dumping more traffic onto the Cape\'s already overburdened highways will further exacerbate traffic issues, particularly on Routes 6A and 28. It would be wiser and a better investment to: 1) build or rebuild the bridges so they are safer, but remain with four lanes on each bridge, and 2) rebuild the rail transit access to the Cape from Boston and Providence through Hyannis and on to Provincetown.
179	Private Citizen	Yes	11/1/2019	Website	X				X												X												I believe that replacing the two bridges to modernize the them and increase their capacities is the best way to approach this project. I question if a broader study been performed to reduce congestion in the area by improving traffic patterns in the area. Installing a flyover at the Bourne Bridge and routing a new highway behind UCCRT and through Joint Base Cape Cod would appear to greatly reduce traffic flows along Sandwich Road and the Scenic Highway which operate well over capacity during the summer. It looks like a more comprehensive approach would be a much better fit for the region rather than patching in new higher capacity bridges that connect to the existing over capacity roadways. I particularly mention this because, as JBCC is federal land, this would look to be the opportune time to pursue this improvement with the Corps. I am also a bit skeptical of the anticipated costs. At less than $1bil, total per bridge, this project appears to be considerably under budgeted. While the new Tappan Zee Bridge was longer and more complicated, that 1 bridge and its roadway improvements were design build and the costs approached nearly $4bil.
180	Private Citizen	Yes	11/1/2019	Website						X											X												First rebuttal is to the determination that the bridges are no longer viable. It is quite easy to produce 'engineering' critiques that diminish the qualities of older structures, and favors the new. Automatic practice in the Profession and amongst those involved in \'doing\' highway construct projects to favor new construction when presented the opportunity. Second criticism is a rejection that new bridges will significantly improve the Cape\'s traffic problems. In fact, that higher capacity crossings can only encourage and increase the flow of traffic into roadways and communities beyond the canal.
181	Private Citizen	Yes	11/1/2019	Website							X										X	X											The replacement bridges should have designated bus lanes to promote public transportation, and the existing train tracks should be upgraded or other train tracks built, also to promote public transportation. The cape does not need and cannot handle more car traffic.
182	Private Citizen	Yes	11/1/2019	Website						X	X										X	X											Reducing jams at the bridges is certainly good, but increasing traffic on already clogged Cape roads would negatively affect both daily life and Cape business. I hope you are studying those effects and taking them into consideration. I am strongly in favor of including a bike/pedestrian lane. Also, wondering whether one of the alternatives you considered was to convert the existing bridges to one-way and build new (presumably cheaper) one-way bridges alongside?

TABLE OF PUBLIC COMMENTS FOLLOWING DRAFT MRER/EA PUBLICATION

					Comment Subject																												
					ALTERNATIVES							ENVIRONMENTAL CONCERNS									TRANSPORTATION					OTHER							
Comment #	Affiliation	Add to Mailing List (Yes/No)	Comment Date	Comment Type	Favor Replacement	Third Bridge	Tunnel	Fill Canal	MassDOT Alternatives	USACE Alternatives	Design Recommendations	Water Quality	T&E Species	Fisheries	Flood Zones/Flooding	Climate Change	Historical/Cultural Concerns	Recreation	Noise/Air Quality	Socioeconomics	Traffic Concerns	Transportation Technology	Tolls	Weight Restrictions/ Concerns	Marine Transportation Considerations	Evacuation Concerns	Safety Concerns	EIS / NEPA Process	Public Involvement/ Communication Concerns	Impacts to Private Property	Timeline of Project	Other	Specific Comments/Questions
183	Private Citizen	Yes	11/1/2019	Website	X						X										X		X										Replace the bridges since they are at the end of their structural lives...BUT with only one wider lane on each side for safety\'s sake, not as an invitation for more visitors to Cape Cod. And please introduce a substantial on- Cape toll between Memorial Day and October 15. to discourage private auto traffic and provide more funding for public transportation (primarily rail) and encourage same in all Cape tourism promotional material.
184	Private Citizen	Yes	11/1/2019	Website	X																X	X					X						Delays due to constant maintenance, lanes shut down due to accidents, backups on weekends (don\'t forget the Tuesday morning after a three-day weekend, which is brutal these days) all impact my life. Even when the bridges are clear, I have to grit my teeth and offset myself so I'm not alongside another car (there isn't room for us both without one of us either hitting the sidewalk or scraping into oncoming traffic) and hope I'm not the next casualty thanks to someone coming from the other direction dropping their phone or falling asleep. It's incredibly stressful to go through twice a day, and it does wear you down. So much of the attention goes to how easy we can make it for off-Cape people to get to the Cape so they can vacation here, but not nearly enough attention is paid to those of us who are professionals living full time on Cape Cod and working on the other side of the bridge. Please try to think in terms of us year-round commuters, too, and not just the city people. Replace these bridges with modern, lovely six-lane versions, yes, please do. Bike lanes would be terrific. But also please please consider doing whatever it takes to also bring the commuter rail down to Hyannis. WHAT a boon that would be in our lives.
185	Private Citizen	Yes	11/1/2019	Website	X																												These bridges both need to be replaced with 6 lane modern bridges to correct the traffic and age conditions.
186	Private Citizen	No	11/1/2019	Website							X						X																Would it at least be possible to make the new bridges look like the old ones? That would soften the impact of the change. Building something that looks completely different would alter the experience of crossing the canal, and not in a good way, it would be a huge disappointment.
187	Private Citizen	No	11/1/2019	Website							X										X	X											Why not add a THIRD lane to either side of the bridge to relieve traffic congestion?? Or one additional lane which can be switched on the west or east direction depending the height of traffic, especially in the summer (think like the HOV on 93 South in Boston. Getting on/off the Cape is so terrible in the Summer months, having that extra lane would be very helpful. Also assuming the new bridge plans have an actual separator/median in-between the west/east lanes as well as wider lanes?
188	Private Citizen	Yes	11/1/2019	Website	X																												The replacement plan as proposed is thoughtful and recognizes the need for dedicated on and off lanes, pedestrian travel, safety considerations, and dedicated 2 lanes each way to accommodate continued traffic flow.
189	Private Citizen	No	11/2/2019	Website			X			X																							Has any study been done to determine if two tunnels would be cheaper and easier to maintain than two new bridges?
190	Private Citizen	Yes	11/2/2019	Website						X												X											Mass transit is the way to go...it works both ways; for tourists and people who commute on and off Cape every day.
191	Private Citizen	Yes	11/2/2019	Website	X						X																						Please add blue LED lights to the new Canal bridges. Maybe blue on the Bourne and green on the Sagamore? Actually, the color of LED lights can be changed, if you include that feature; might make for some fun and creative options! Maybe make them so they can spell out CAPE COD to boaters below. With all the cruise ships now sailing the Canal, that could be a very popular photo opp!
192	Private Citizen	Yes	11/2/2019	Website							X										X	X											Would like to see plans for other transportation, such as rail, added to the bridges coming onto the Cape. It is great new bridges are proposed however what happens to all those cars once they cross on to the Cape. We already have congestion and too much vehicle traffic

TABLE OF PUBLIC COMMENTS FOLLOWING DRAFT MRER/EA PUBLICATION

					Comment Subject																												
					ALTERNATIVES							ENVIRONMENTAL CONCERNS									TRANSPORTATION					OTHER							
Comment #	Affiliation	Add to Mailing List (Yes/No)	Comment Date	Comment Type	Favor Replacement	Third Bridge	Tunnel	Fill Canal	MassDOT Alternatives	USACE Alternatives	Design Recommendations	Water Quality	T&E Species	Fisheries	Flood Zones/Flooding	Climate Change	Historical/Cultural Concerns	Recreation	Noise/Air Quality	Socioeconomics	Traffic Concerns	Transportation Technology	Tolls	Weight Restrictions/ Concerns	Marine Transportation Considerations	Evacuation Concerns	Safety Concerns	EIS / NEPA Process	Public Involvement/ Communication Concerns	Impacts to Private Property	Timeline of Project	Other	Specific Comments/Questions
193	Private Citizen	Yes	11/2/2019	Website				X	X	X											X												The mandate is to find the most reliable fiscally responsible solution for the future. That isn't a bridge! Fill the canal in with soil at the two locations and build a highway! Cheaper construction and fewer limitations. A bridge is something designed to keep engineers and maintenance workers employed!"
194	Private Citizen	Yes	11/2/2019	Website											X							X	X									X	The Cape and Islands transportation, shoreline protection and waste water treatment infrastructures are perennial public financial challenges which revenue from canal bridge tolls could help relieve. Electronic tolling systems should be implemented so non-resident vehicles help fund construction and maintenance of current and any new bridges. Non-residents who work on the Cape and Islands should receive toll waivers.
195	Private Citizen	No	11/2/2019	Website						X																							Keep the current bridges and keep them with the corps of engineers.
196	Private Citizen	Yes	11/2/2019	Website					X	X	X										X	X								X			New Sagamore bridge with a 4-lane, median, combined pedestrian and bike lane & auxiliary lanes. Coming on and off, the traffic will still back up with six lanes of cars headed over from Rte. 3 and off to Rte. 6. Why displace families & businesses (eminent domain) with wide 6 lane bridge. Most of the traffic Memorial Day to Labor Day. Bourne Bridge 4-lane etc. Create a flyover. Traffic should be able to go off to the left of the current rotary & create a new road that follows the fringes of Otis along the canal. Utilize the train & create a ferry service to alleviate traffic over both bridges. Rtes 3, 6, 25 & 28 can't handle 6 lanes of bridge traffic.
197	Private Citizen	Yes	11/3/2019	Website					X		X						X				X												Cape already experiences more traffic than its' roads can handle, and Route 6 and Route 28 are two lane roads. I would like to see the new bridges be two lanes. The new bridges should have a wide sidewalk-bike way on the same side of the bridge as the present ones. It would be nice if the design for the new bridges was similar to the Art Deco design of the old bridges. The design of the old bridges is sort of iconic and part of the image of Cape Cod.
198	Private Citizen	Yes	11/3/2019	Website															X										X	X	X		I live very close to the possible construction and have not been notified about any of these meetings. I would like to attend and have my opinion heard on these matters. Those in my neighborhood are scared to lose their homes and scared that if they do they won\'t be compensated properly. Are we going to be left without homes and left owing on a mortgage on a home that is gone?
199	Private Citizen	Yes	11/3/2019	Website				X	X																								What do we need the canal for currently? Fix the rotary on the south side of the Bourne Bridge so people coming on Cape and headed to route 6 don't stop people trying to get off Cape. That's a daily problem year round. The tourist traffic isn't a reason to add a bridge. If replacement is required look at alternatives to the high span bridges we have now.
200	Private Citizen	Yes	11/3/2019	Website	X																												Yes we absolutely think that the bridges should be replaced.
201	Private Citizen	Yes	11/3/2019	Website			X			X																							My entire life the Cape Cod Canal Tunnel" has been a funny locals joke. Has anyone given thought to the fact a tunnel or two would be an amazing solution to this issue?
202	Private Citizen	Yes	11/3/2019	Website					X	X											X	X											Disapprove of wider bridges to access Cape Cod. The traffic backup at the bridges is a deterrent which helps regulate numbers of people on the already overcrowded sand bar. We should be investing in non-polluting infrastructure renovation such as ferries for freight to Martha's Vineyard from New Bedford by water. Public transportation in the form of Busses, Trains and Ferries from Bourne and South Coast communities could distribute the burden of congestion and the wealth of commerce and tourism.
203	Private Citizen	Yes	11/3/2019	Website					X		X						X																Please omit the rotary. Keep the cape cod feel in the bridge design

TABLE OF PUBLIC COMMENTS FOLLOWING DRAFT MRER/EA PUBLICATION

Comment #	Affiliation	Add to Mailing List (Yes/No)	Comment Date	Comment Type	Comment Subject																												Specific Comments/Questions
					ALTERNATIVES							ENVIRONMENTAL CONCERNS									TRANSPORTATION					OTHER							
					Favor Replacement	Third Bridge	Tunnel	Fill Canal	MassDOT Alternatives	USACE Alternatives	Design Recommendations	Water Quality	T&E Species	Fisheries	Flood Zones/Flooding	Climate Change	Historical/Cultural Concerns	Recreation	Noise/Air Quality	Socioeconomics	Traffic Concerns	Transportation Technology	Tolls	Weight Restrictions/ Concerns	Marine Transportation Considerations	Evacuation Concerns	Safety Concerns	EIS / NEPA Process	Public Involvement/ Communication Concerns	Impacts to Private Property	Timeline of Project	Other	
204	Private Citizen	Yes	11/3/2019	Website																									X	X	X		Wish the study said that we are taking these people property and we will pay them this amount and when do we get paid and how long do we have to move out and how much money does it cost to move and can we add that to price they will pay..I have an illness that is going to get worse so I want to pass in my home of 37 years was my plan...I could live another 15 yrs. I just want to know about the money we will have to relocate.
205	Private Citizen	Yes	11/3/2019	Website																										X		X	In hopes that you will treat the people who you will be taking land from, as well as residences and businesses fairly. History shows us that people get ridiculously low payments in eminent domain payments. I would suggest that you pay the people six times what the town values their property at to alleviate their needs to relocate, lawyers fees and purchase of new properties.
206	Private Citizen	Yes	11/3/2019	Website						X											X	X											Consideration should be given to the fact that an expansion of lanes on both bridges will only increase vehicle volume funneled on to Routes 6 & 28, neither of which can handle the current traffic coming off of these bridges during the summer season. Certainly a bike lane and the inclusion of a rail line connection could provide both traffic relief and help with the reduction of emissions.
207	Private Citizen	Yes	11/3/2019	Website							X										X	X											I'm concerned about any new bridges being wider than the current ones to allow more traffic onto the Cape. There is already far too much traffic on the Cape, caused by a lack of mass transit. If there are more lanes than the current bridges have, they should be bus or carpool lanes. And the new bridges should definitely have tolls, which would incentivize people to take the bus or train, or to carpool. Increasing traffic and pollution is terrible for the Cape. Please make sure the new bridges do not include additional car lanes.
208	Private Citizen	Yes	11/4/2019	Website				X			X																					X	I know I have heard that filling in the canal doesn't make sense....but I guess I'm wondering why? Couldn't the middle part be filled in connecting current infrastructure to a new span crossing the canal where currently water flows? At a much less price tag? And could the open end be converted to hydro electric power given that water will still fill in and out with the tides? How come more thought hasn't been given to this concept? Is it strictly because Cape Cod is defined by the canal?
209	Private Citizen	Yes	11/4/2019	Website	X																	X											I applaud the upgrade of the bridges. I would hope that you would consider expanded rail service across the bridges to enable faster rail travel. If not possible then perhaps some other mass transportation enabler like a bus lane for peak traffic.
210	Private Citizen	Yes	11/4/2019	Website	X						X											X											Yes, the bridges need to be replaced. Please consider that even if the bridges are new and bigger, they still feed into a two-lane highway. Cape Cod does not need an expanded Route 6 to accommodate event more cars trying to squeeze onto the peninsula (which we just know will be the next suggestion -- let's widen Route 6). New, safe bridges to accommodate today's larger vehicles, yes, but keep them to two lanes in each direction, with a system for making at least three of the lanes one way in emergency situations.
211	Private Citizen	Yes	11/5/2019	Website																									X	X		X	Concerned about eminent domain, being fairly compensated, and support from the local, state and federal government during the process.
212	Private Citizen	Yes	11/5/2019	Website	X																X									X			Concerns for at least 6 lanes of traffic merging into 2 lanes of traffic on both Cape sides. Would urge any land taking being at above market value to compensate for disruption . Strongly believe new bridges more cost effective than continually throwing good money after bad.
213	Private Citizen	Yes	11/5/2019	Website				X																									Has anyone considered an out-of- the box "no bridges" option and building a land bridge across the canal? Consider the saved maintenance on future structures and money better spent on highway access

TABLE OF PUBLIC COMMENTS FOLLOWING DRAFT MRER/EA PUBLICATION

Comment #	Affiliation	Add to Mailing List (Yes/No)	Comment Date	Comment Type	Comment Subject																												Specific Comments/Questions
					ALTERNATIVES							ENVIRONMENTAL CONCERNS									TRANSPORTATION					OTHER							
					Favor Replacement	Third Bridge	Tunnel	Fill Canal	MassDOT Alternatives	USACE Alternatives	Design Recommendations	Water Quality	T&E Species	Fisheries	Flood Zones/Flooding	Climate Change	Historical/Cultural Concerns	Recreation	Noise/Air Quality	Socioeconomics	Traffic Concerns	Transportation Technology	Tolls	Weight Restrictions/ Concerns	Marine Transportation Considerations	Evacuation Concerns	Safety Concerns	EIS / NEPA Process	Public Involvement/ Communication Concerns	Impacts to Private Property	Timeline of Project	Other	
214	Private Citizen	Yes	11/5/2019	Website																	X	X											The Cape does not need and can not handle more cars and traffic. Bringing more people over the bridge more swiftly only encourages more people - and shouldn't encourage single use cars
215	Private Citizen	Yes	11/5/2019	Website																	X	X											We do not want or need more single car trips on the Cape! When you bring cars more swiftly and efficiently onto 28 toward Falmouth - then what? Three lanes to two at the rotatory or just after it. Build to support MAss transit not more cars.
216	Private Citizen	Yes	11/5/2019	Website		X																X										X	Under the authority of the National Industrial Recovery Act of June 1933 the Public Works Administration authorized the construction of three bridges over the canal, two highway and one railroad, in keeping with the terms of the original state charter. I am concerned that the current plan is short sighted. The evaluation should include either a discussion of one of the highway bridges being considered for a rail line or an acknowledgement that the rail bridge replacement will be addressed in a subsequent evaluation. The Evaluation Report is silent on the railroad bridge.
217	Cape Cod Chamber of Commerce	No	10/17/2019	Public Meeting	X																X						X						Cape Cod Chamber of Commerce supports the replacement of the two bridges. Project goals is not to be able to increase traffic over the bridges during the peak seasons, rather the safety of all travelers, and restoring reliability in the transportation system.
218			10/23/2019	Public Meeting																												X	Inquiring if there is any consideration being made regarding a proposed casino in Wareham that may be planned?
219	Private Citizen	Yes	10/30/2019	Email							X																						Proposes the new bridge design be inspired by Malcolm Wells and his ability to blend structures with nature in a "land-bridge" type design.
220	North Sagamore Water District		10/29/2019	Written																									X			X	States that the draft out forth by the USACE does not account for the water department infrastructure currently in place. States that design currently goes right through existing infrastructure. Wishes to be involved in all planning and decision making in the coming months. Worries that the cost of the relocation of infrastructure if not taken by the USACE would ruin the budgeting for the area. Supplemental Agreement number 1 between the Secretary of the Army and the North Sagamore Water District is attached.
221	Director, Massachusetts Chapter of the Sierra Club		10/29/2019	Written					X	X	X					X			X														Traffic is the main source of CO2 emissions in Massachusetts, which in turn exacerbates major health conditions. Stated they do not support the increase in size of the bridge to accommodate more traffic due to the reliance on a single aquifer for water, and inadequate wastewater infrastructure. Stated there needs to be priority for bikes and pedestrians, also support investments in improved railways for the Cape. Explore the idea of keeping existing infrastructure and converting it to new uses.
222	Director/Town Engineer, Sandwich Department of Public Works	Yes	10/26/2019	Written	X				X												X						X						Provided letter attached that was addressed to MassDOT based on their transportation study in June. Comments towards MassDOT included safety concerns at intersections, the need for improved signals at intersections, concerns about changing asthetics, traffic concerns and relocations of exits.
223	Cape Cod and Island Legislative Delegation		10/24/2019	Written	X												X				X						X						Stated their support of the replacement of the two bridges. Stated they wish for increased safety on the bridges, and a decrease in travel congestion. They support the findings of the EA and they appreciate the collaboration between USACE and MassDOT. They wish to maintain historical and cultral pieces of the canal and surrounding areas.
224		Yes	11/5/2019	Website						X	X																						The two bridges are only five miles apart. Perhaps one super-bridge could accommodate the majority of Cape traffic from I-19 and MA routes 3, 25, 28, and 6. One of the existing bridges might also be maintained as a fallback/alternative/local-traffic bridge. Just an idea. No engineering or traffic-management expertise here. The proximity of the two just seems to offer the possibility.

TABLE OF PUBLIC COMMENTS FOLLOWING DRAFT MRER/EA PUBLICATION

Comment #	Affiliation	Add to Mailing List (Yes/No)	Comment Date	Comment Type	Comment Subject																												Specific Comments/Questions
					ALTERNATIVES							ENVIRONMENTAL CONCERNS									TRANSPORTATION					OTHER							
					Favor Replacement	Third Bridge	Tunnel	Fill Canal	MassDOT Alternatives	USACE Alternatives	Design Recommendations	Water Quality	T&E Species	Fisheries	Flood Zones/Flooding	Climate Change	Historical/Cultural Concerns	Recreation	Noise/Air Quality	Socioeconomics	Traffic Concerns	Transportation Technology	Tolls	Weight Restrictions/ Concerns	Marine Transportation Considerations	Evacuation Concerns	Safety Concerns	EIS / NEPA Process	Public Involvement/ Communication Concerns	Impacts to Private Property	Timeline of Project	Other	
225		Yes	11/6/2019	Website					X		X										X						X						I don't think the bridges can be designed in isolation. A regional transportation plan needs to be part of the thinking. If the new bridges enable/encourage more people to come, where will they go once they're here? Traffic on the Cape in summer is already horrible. We need more public transport, serious bike lane options. On the design specifically, I'm curious how the bike/ped lane, which is only on one side of the bridges, will tie in to secondary streets going in two directions. There needs to of course be safe conveyance from the bridge onto local streets for bikers/peds going both ways, without having to cross streets.
226		No	11/6/2019	Website	X																						X						The Sagamore bridge is our lifeline to the mainland. There has been many a time where we have been delayed or felt unsafe driving on the tight bridge not meant for the size of modern cars this day. Box trucks have to straddle the two lanes just to fit across - and it seriously lacks safe lanes for bikers. I'm all for a replacement of the Sagamore bridge, money would be better spent on a replacement vs yearly repairs.
227		Yes	11/6/2019	Website												X					X					X	X						The bridge situation needs resolution for several reasons. First and foremost is safety in the case an evacuation is necessary. Secondly is traffic which is annoying but also very detrimental to the environment!
228		Yes	11/6/2019	Website					X												X	X											While I understand the need for new bridges onto the Cape, the plans and designs MUST be connected to a broader regional transportation network. Bigger bridges, with more lanes, will not change the size and capacity of roads feeding them or receiving them. Expansion of alternative travel modes (from cars to public transport) should be part of the design. These bridges are truly \bridges to the future\" and as such should be planned with a sustainable future in mind.
229		No	11/6/2019	Website						X						X						X											Use this opportunity to consider forward-looking solutions that take into account the Cape's huge traffic issues and escalating climate change realities -- do NOT just build wider, bigger bridges that will add more cars to our already over-burdened roads.
230	300 Committee Land Trust	Yes	11/6/2019	Website					X																		X					X	Please provide a safe designated bike/pedestrian lane on the bridges. Also consider linking this lane directly to the bike path on each side of the canal. Being able to safely cross the bridge on foot or by bike will greatly enhance a healthy community. If any linkage exists to hiking trails please include that access as well.
231		Yes	11/6/2019	Website							X																					X	I support your study, but I would like to have you include the following items: 1. Will the single bike lane over the bridge be sufficiently wide to allow recumbent tricycles going in opposite directions to easily pass? 2. How will the single bike lane at each end allow a bike to either get into the bridge lane or to exit? This would be especially acute going onto the Cape. 3. Will the bridges be coordinated with then xisiting or proposed regional transportation plans?
232		No	11/6/2019	Website					X																							X	Thank you for getting started on this massive undertaking! I appreciate the inclusion of a bike path on the bridge, but something I would appreciate knowing about is how the bike path and the merge lanes in the 4+2 configuration actually lay out in the transition to existing roadways. My fear is that to access the bridge by bike, I'll need to bike several additional miles just to get to the start point for that lane.
233		Yes	11/6/2019	Website						X																						X	Please ensure a safe bike lane on the bridge in both directions so that bikers can tie into secondary roads on both sides of the canal.
234	Snows Home and Garden	Yes	11/6/2019	Website	X				X																					X		X	I applaud the project, which is well overdue. the only other alternative I have long proposed is to close the off cape Exit 1 on ramp, which would impact the local residents more than land taken to build another bridge. it is important to compensate those land owners well for taking their land. hopefully the rotary at Bourne bridge will be removed.

TABLE OF PUBLIC COMMENTS FOLLOWING DRAFT MRER/EA PUBLICATION

Comment #	Affiliation	Add to Mailing List (Yes/No)	Comment Date	Comment Type	Comment Subject																												Specific Comments/Questions
					ALTERNATIVES							ENVIRONMENTAL CONCERNS									TRANSPORTATION					OTHER							
					Favor Replacement	Third Bridge	Tunnel	Fill Canal	MassDOT Alternatives	USACE Alternatives	Design Recommendations	Water Quality	T&E Species	Fisheries	Flood Zones/Flooding	Climate Change	Historical/Cultural Concerns	Recreation	Noise/Air Quality	Socioeconomics	Traffic Concerns	Transportation Technology	Tolls	Weight Restrictions/ Concerns	Marine Transportation Considerations	Evacuation Concerns	Safety Concerns	EIS / NEPA Process	Public Involvement/ Communication Concerns	Impacts to Private Property	Timeline of Project	Other	
235		Yes	11/6/2019	Website	X																X						X						New/renewed canal bridges would be really great but what about the additional traffic that will be created on the Cape due to more people using those bridges? Are there plans in place to address our current and future seasonal traffic needs? Also, barricaded bike lines on going both ways on each bridge will encourage more people to travel via bike and most importantly - keep them safe!
236		Yes	11/6/2019	Website	X				X												X				X							X	The structures of the bridges is something that we need to consider. They are very old and probably need to be rebuilt. However, they need to be built with the future transportation/environmental needs in mind. There should be two bike/pedestrian lanes, one on each side ending with a safe connection to side roads/bike path. Public transportation needs to be considered, perhaps bus lane/car pool lane. I think the existing railroad bridge should be part of the plan with a commuter and or freight train as part of a master transportation plan. However, along with the bridge construction, Steamship Authority must begin routing truck traffic to New Bedford. A new bridge will bring more traffic and the Cape itself just can't handle it. With hundreds of trucks presently coming over the bridges every day driving all the way to Woods Hole village/ Hyannis to board the ferry to MV and Nantucket is just excessive and destructive to environment of the connecting towns. Without adding a new terminal for MV a new bridge will only encourage more truck traffic and the Cape will be gridlocked, as well as polluted with fumes and noise.
237		Yes	11/6/2019	Website	X				X							X						X											I am a resident of Falmouth, MA, who sees the difference between summer and the rest of the year. Our street runs along, Woods Hole Rd, (28) and is a bypass for traffic. It is a windy road and as a biker I and many others enjoy biking on the road. It is really too narrow for large trucks and cars need to pay attention to bicycles and pedestrians. We used to have train service, that has now been turned at least in part into a bike path. We are an aging population. We miss trains and public transportation and have too many cars and drivers, damage to the environment. In brief, constructing new bridges should include decent bike and pedestrian traffic and ideas to increase public transportation and keep driving down
238		Yes	11/6/2019	Website					X												X	X											as a Falmouth resident I certainly find the bridge on or off Cape backups annoying but realistically, what is the benefit of more quickly shoveling more cars onto the Cape if they immediately enter the existing roads infrastructure? Please prioritize increased mass transit, car-pooling, cycling and other means of reducing single- driver and fossil fuel use in any future planning
239		Yes	11/6/2019	Website					X													X					X						Please include legitimate facilities for cyclists to cross safely. The current situation is unacceptable. Check out Richmond Virginia for an example. Also include facilities for train traffic. Please don't build only for cars!
240		Yes	11/6/2019	Website	X																X						X						Sounds great. The Cape needs new bridges for traffic concerns and for safety concerns.
241		Yes	11/6/2019	Website						X							X															X	I strongly urge you to consider rehabilitating the existing bridges as they are. I have read every article, plan, and study to date. While some people would call the impact of replacing the bridges minimal it s far from that. The impact on residents, businesses, wildlife and the and the environment is far too great. These grand bridges have served us well over the years. From a historical standpoint alone they deserve care and maintenance. It would be a disservice to destroy such an iconic part of Cape Cod life. Please continue as you always have and maintain the bridges and safe passage for residents and visitors alike.
242		Yes	11/6/2019	Website							X																X						Would love a protected access across this bridge. It is really scary right now. Adding a curb separated cycletrack on both sides would be a welcome addition. My wife and I love biking down to the cape and would appreciate having this.

TABLE OF PUBLIC COMMENTS FOLLOWING DRAFT MRER/EA PUBLICATION

Comment #	Affiliation	Add to Mailing List (Yes/No)	Comment Date	Comment Type	Comment Subject																												Specific Comments/Questions
					ALTERNATIVES							ENVIRONMENTAL CONCERNS									TRANSPORTATION					OTHER							
					Favor Replacement	Third Bridge	Tunnel	Fill Canal	MassDOT Alternatives	USACE Alternatives	Design Recommendations	Water Quality	T&E Species	Fisheries	Flood Zones/Flooding	Climate Change	Historical/Cultural Concerns	Recreation	Noise/Air Quality	Socioeconomics	Traffic Concerns	Transportation Technology	Tolls	Weight Restrictions/ Concerns	Marine Transportation Considerations	Evacuation Concerns	Safety Concerns	EIS / NEPA Process	Public Involvement/ Communication Concerns	Impacts to Private Property	Timeline of Project	Other	
243		No	11/6/2019	Website					X												X	X					X						I do believe that we are in need of new bridges not just from a traffic issue but also a safety issue. However I also feel there is a great need for an overall public transportation plan addresssing transportation modes for those coming to the Cape as well as the incredible need for better public transportation on the Cape. I live in Falmouth and our Main Street is bumper to bumper in the summer months with cars barely moving. If this is not addressed for Falmouth and I am sure for every town on the Cape we will lose our tourism business. Of course the effects of inadequate public transportation nd the lack of better bikeways has a very detrimental effect on the environment also and this is not the time for that to happen. Please consider creating a Cape and Islands overall transportation before we build bridges that will bring more people to our overcrowded roads.
244	WHOI	Yes	11/6/2019	Website					X												X	X											The bridges need to be developed within the overall concept of a southeastern Massachusetts regional transportation plan (including the Cape and islands), which is non-existant as far as I can tell. Marthas Vineyard needs ferries and barges to and from New Bedford connecting to rail lines to Boston and Providence. The summer traffic is horrible on the Cape and Islands in the summer; we don't need more trucks and cars coming over the bridges without plans for what they can do when they get here. Better to divert those heading for Woods Hole and Marthas Vineyard to New Bedford ferries. And to do that we need to fix the New Bedford State Pier. The elements of the whole transportation system need to be developed together, not just \the bridges." Think big and comprehensively. Do not consider one element (bridges) by itself. Please remember there are lots of people who live on the Cape and Islands that are already overwhelmed by the excessive traffic coming over the existing bridges. Please don't make it worse by "fixing" the bridges and adding more trucks and cars to the Cape gridlock."
245		Yes	11/6/2019	Website					X												X	X											I feel it is a mistake to design the bridges without a regional transportation plan. If the new bridges enable more summer visitors, how will our already traffic-choked roads handle it? Please consider more public transport to and on the Cape as well as bike lanes on both sides of the proposed bridge so that cyclists can safely access secondary roads on both sides
246		No	11/7/2019	Website	X						X																						The MRE study makes it abundantly clear that the most prudent course of action is to replace the ageing Cape Cod Canal Bridges and to do so immediately. Indeed, any additional delays are likely to leave Cape and Islands residents in the worst possible scenario of having to pay twice once for the rehabilitation in the mid-2020s and again for their eventual replacement”all the while being stuck with the existing, inadequate infrastructure. I believe it makes the most long-term financial sense to replace the existing bridges with structures that include auxiliary entrance/exit lanes as well as non-vehicle bike/pedestrian lane. Such a structure would offer the greatest payoff in terms of reduced congestion and increased accessibility to other types of traffic. Should the eight-lane deck proposal be adopted, I would encourage the Commonwealth of Massachusetts to follow the recommendations of the Cape Cod Transportation Study and commit to upgrading the infrastructure surrounding the bridges (e.g., Rt. 6, Bourne rotary), such that the full benefits of the replacement structures can be realized.

TABLE OF PUBLIC COMMENTS FOLLOWING DRAFT MRER/EA PUBLICATION

Comment #	Affiliation	Add to Mailing List (Yes/No)	Comment Date	Comment Type	Comment Subject																												Specific Comments/Questions
					ALTERNATIVES							ENVIRONMENTAL CONCERNS									TRANSPORTATION					OTHER							
					Favor Replacement	Third Bridge	Tunnel	Fill Canal	MassDOT Alternatives	USACE Alternatives	Design Recommendations	Water Quality	T&E Species	Fisheries	Flood Zones/Flooding	Climate Change	Historical/Cultural Concerns	Recreation	Noise/Air Quality	Socioeconomics	Traffic Concerns	Transportation Technology	Tolls	Weight Restrictions/ Concerns	Marine Transportation Considerations	Evacuation Concerns	Safety Concerns	EIS / NEPA Process	Public Involvement/ Communication Concerns	Impacts to Private Property	Timeline of Project	Other	
247		Yes	11/7/2019	Website						X	X										X											X	The bridges are a icon to the cape and i would like to see a twin bridge a long side both bridges.The old bridges would go on cape and the new ones would go off cape. get rid of the rotary make ramps.these steel bridges are built strong and need to be maintained. i'm sure it would cost millions to take them down. that was not mentioned in the cost. one other thought when looking at the Arial view i notice the long curve on rt.25 is close to the canal and close to the main power lines to cross the canal with a third new bridge or tunnel almost center of the old bridges but that would be a major job.
248		Yes	11/7/2019	Website							X										X	X										X	I understand that the cost of maintaining the existing bridges will be higher, in the long run, than building new ones. For this reason, it makes sense to replace them. However, I disagree with any argument that increasing the number of lanes will decrease traffic congestion. There have been multiple economic studies on what's called induced demand. It means that if supply is increased more of a good (in this case driving) is consumed. In fact there is even a "Fundamental Law of Road Congestion that shows how increasing highway lanes fails to ease traffic. For these reasons alternative measures need to be taken if we're serious about reducing summer congestion. At the very least the third traffic lane should be reserved for buses and high occupancy vehicles. It would be great to see a larger commitment to public transit like better rail connections and bus service.
249		Yes	11/7/2019	Website	X																												All in favor of replacement.
250		Yes	11/7/2019	Website						X	X										X												Cape Cod has too many autos now. Nothing should be done with the bridges that would increase their total capacity. Increased vehicle capacity would induce more drivers to cross the bridges, until congestion increased to where it is now, though with more cars and trucks diminishing the Cape. No one would build the world's widest canal at that site now, given modern maritime travel. The canal could be narrowed at the places where bridges will cross. Vertical clearance also does not need to be anywhere near as much as it is now. The long ascent and descent on our bridges results in vehicles wasteful use of fuel and brakes.
251		Yes	11/7/2019	Website					X		X											X											As a resident of Pocasset, MA, a dedicated bike commuter, and also a regular traveler over the Bourne and Sagamore Bridges, I feel strongly that it would benefit residents and visitors to consider new bridge configurations in the context of larger scale regional transportation. For example, a single bike lane requires crossing heavily trafficked intersections to continue on safe bike routes. Please consider how bike lanes will tie in to the on and off ramps and surrounding safe roads for bike commuting. Please also consider how public transportation options will utilize the new bridges. This will alleviate car traffic pressure that is already stifling on Cape.
252		Yes	11/7/2019	Website	X				X		X																						While I support the idea of replacing the bridges, I can't fathom other needs being incorporated into the project: - Replacement of the Bourne Rotary to move traffic more efficiently onto 28 South and 6 East (similar to what was done several years ago at the Sagamore Rotary). - Concern about the benefit of additional lanes on the bridge without a clear plan on how that will ease congestion if no additional lanes on both sides of the Bourne Bridge! - Lack of foresight in reserving some of these lanes for public transportation and/or HOV lanes.
253		Yes	11/7/2019	Website	X						X																					X	Please make the bridge adequate for the future needs of cape cod including a bike lane and consider the economic effects during construction.

TABLE OF PUBLIC COMMENTS FOLLOWING DRAFT MRER/EA PUBLICATION

Comment #	Affiliation	Add to Mailing List (Yes/No)	Comment Date	Comment Type	Comment Subject																												Specific Comments/Questions
					ALTERNATIVES							ENVIRONMENTAL CONCERNS									TRANSPORTATION					OTHER							
					Favor Replacement	Third Bridge	Tunnel	Fill Canal	MassDOT Alternatives	USACE Alternatives	Design Recommendations	Water Quality	T&E Species	Fisheries	Flood Zones/Flooding	Climate Change	Historical/Cultural Concerns	Recreation	Noise/Air Quality	Socioeconomics	Traffic Concerns	Transportation Technology	Tolls	Weight Restrictions/ Concerns	Marine Transportation Considerations	Evacuation Concerns	Safety Concerns	EIS / NEPA Process	Public Involvement/ Communication Concerns	Impacts to Private Property	Timeline of Project	Other	
254		No	11/8/2019	Website						X									X		X								X	X			For this tiny geographic region, the proposed bridges are absurdly oversized. In its current form, the proposal is caricature-like! We don't need two oversized bridges. If this proposal is implemented, it will drastically increase private vehicle traffic; thereby polluting this neck of the woods even further. This is an outcome that some people are failing to comprehend: The proposed oversized bridges will only serve to attract even more private vehicle traffic. It will not reduce congestion. The impact on the environment (11 acres in a tiny geographic area) is just atrocious. So many displaced wildlife, people, and destroyed homes due to wanton destruction only for more tourists to clog our roads! In conclusion, these bridges (and the impending construction) will impact the residents of Bourne in a way that other Cape residents will never understand. Therefore, as it impacts them irreparably, the residents of Bourne should have the most say over the final details.
255		Yes	11/8/2019	Website					X		X											X					X						Any contemplated replacement of the Bourne and Sagamore bridges must prioritize excellent facilities for both pedestrians and cyclists to use the bridges as well as safe connections to the region's path and trail networks, including the Cape Cod Canal Recreation Paths along both sides of the Cape Cod Canal. The facilities for cyclists and pedestrians on the existing bridges is unacceptable and treacherous, and severely limits connectivity for the neighborhoods and communities, like Bourne where I live and Sandwich where I work, along the Cape Cod Canal. Any and all bridge replacement should include state-of-the art facilities for pedestrians and cyclists on the bridges as well as providing substantially improved access to the bridges for both pedestrians and cyclists. The U.S. Army Corps of Engineers and other stakeholders should prioritize safe bike and pedestrian infrastructure that directly links the new bridges to the Cape Cod Canal Recreation Path on both sides of the Canal.
256		Yes	11/8/2019	Website					X										X		X	X			X							X	I have read that improved infrastructure often means more traffic. I would like someone more knowledgeable than I to solve this ultimate congestion matter for the Cape. I live for example in the bottleneck of Woods Hole. The situation here is unbearable. Could there be a fee for truck so as to encourage freight travel from New Bedford? That is not available now but in a long range plan this would be most important. Could there be off Cape node points for more efficient distribution for good and materials especially good and material going to the Islands. We need carbon footprints to drop. The State also has an interest in lowering the carbon footprint. In planning for the bridge please see if there is anything that you can include in the plan that would serve the region as a region not just separate destinations each to their own. Residents could have a pass. Visitors could pay a fee to discourage passing by New Bedford as an alternate route to Martha\'s Vineyard. New Bedford is a likely port but perhaps there are other options. Bridge planning should not be a stand alone event. It really needs a regional component to the plan. Many people would greatly appreciate a plan that contains an awareness of the regional impact of transportation activity
257		Yes	11/8/2019	Website					X																		X						It is very important that pedestrians and cyclists be able to use the Bourne and Sagamore bridges safely. Access to the bridges should provide, at a minimum, direct links to the Cape Code Canal Recreation Path on both sides of the Canal. Safe connections to the Cape's path and trail networks are also important to provide.

TABLE OF PUBLIC COMMENTS FOLLOWING DRAFT MRER/EA PUBLICATION

Comment #	Affiliation	Add to Mailing List (Yes/No)	Comment Date	Comment Type	Comment Subject																												Specific Comments/Questions
					ALTERNATIVES							ENVIRONMENTAL CONCERNS									TRANSPORTATION					OTHER							
					Favor Replacement	Third Bridge	Tunnel	Fill Canal	MassDOT Alternatives	USACE Alternatives	Design Recommendations	Water Quality	T&E Species	Fisheries	Flood Zones/Flooding	Climate Change	Historical/Cultural Concerns	Recreation	Noise/Air Quality	Socioeconomics	Traffic Concerns	Transportation Technology	Tolls	Weight Restrictions/ Concerns	Marine Transportation Considerations	Evacuation Concerns	Safety Concerns	EIS / NEPA Process	Public Involvement/ Communication Concerns	Impacts to Private Property	Timeline of Project	Other	
258		Yes	11/8/2019	Website					X																							X	Any contemplated replacement of the Bourne and Sagamore bridges must prioritize excellent facilities for both pedestrians and cyclists to use the bridges as well as safe connections to the region's path and trail networks including the Cape Cod Canal Recreation Paths along both sides of the Cape Cod Canal. The facilities for cyclists and pedestrians on the existing bridges is unacceptable and treacherous and severely limits connectivity for the neighborhoods and communities in Bourne and Sandwich along the Cape Cod Canal.
259	Vineyard Wind	Yes	11/8/2019	Website	X					X	X																						Vineyard Wind is pleased to submit the following comments on the Major Rehabilitation Evaluation (MRE) Study of the Bourne and Sagamore Highway Bridges. The rehabilitation or replacement of this critical transportation infrastructure is clearly a top priority for the residents and businesses of Cape Cod and Massachusetts. The Vineyard Wind offshore wind project is connecting to the electric grid on Cape Cod and depends on a reliable transportation network of bridges and roads. In addition, we encourage the US Army Corps of Engineers to include and evaluate design alternatives to accommodate additional electric transmission cables that could be installed on or under the bridges and span the Cape Cod Canal as part of a rehabilitation/replacement project. Additional high voltage transmission lines and other upgrades to the regional electric grid will be needed to accommodate new power generation (e.g. offshore and onshore wind, solar, battery storage) as it continues to be added to the regional energy supply. These canal crossings could provide important new regional transmission infrastructure and capacity, which could be done with lower cost and disruption if done as part of the bridge rehabilitation replacement project.
260		Yes	11/8/2019	Website					X		X																					X	Any contemplated replacement of the Bourne and Sagamore bridges must prioritize excellent facilities for both pedestrians and cyclists to use the bridges as well as safe connections to the region\'s path and trail networks including the Cape Cod Canal Recreation Paths along both sides of the Cape Cod Canal. The facilities for cyclists and pedestrians on the existing bridges is unacceptable and treacherous and severely limits connectivity for the neighborhoods and communities in Bourne and Sandwich along the Cape Cod Canal.
261		Yes	11/8/2019	Website							X																						As a concerned citizen of Bourne, MA, I would like to see a bicycle and pedestrian trail (with safe access) on any new automobile bridge built over Cape Cod Canal. I realize that some of the design options include bike access, but I hope that any chosen option will include such access.
262		Yes	11/8/2019	Website							X																						As plans are being made to address the replacement of both the Sagamore and Bourne Bridge, I would ask that consideration be given for the inclusion of plans for bicycle access two both Bridges. This would coincide with work already being undertaken to have Bikeway access across Cape Cod. Safe access to Cape Cod should not only be limited to vehicles.
263		Yes	11/8/2019	Website	X																												Fantastic news about the funding for Stage 4 and the success of the BBC matching gift. Kudos to the committee for getting right. The bike path will enhance the quality of life for everyone who lives or visits the area. Better for the environment, safer and more healthy for users, better views of the marsh and beaches, reduction of traffic, new business ops for the townships. What more could we ask.

TABLE OF PUBLIC COMMENTS FOLLOWING DRAFT MRER/EA PUBLICATION

Comment #	Affiliation	Add to Mailing List (Yes/No)	Comment Date	Comment Type	Comment Subject																												Specific Comments/Questions
					ALTERNATIVES							ENVIRONMENTAL CONCERNS									TRANSPORTATION					OTHER							
					Favor Replacement	Third Bridge	Tunnel	Fill Canal	MassDOT Alternatives	USACE Alternatives	Design Recommendations	Water Quality	T&E Species	Fisheries	Flood Zones/Flooding	Climate Change	Historical/Cultural Concerns	Recreation	Noise/Air Quality	Socioeconomics	Traffic Concerns	Transportation Technology	Tolls	Weight Restrictions/ Concerns	Marine Transportation Considerations	Evacuation Concerns	Safety Concerns	EIS / NEPA Process	Public Involvement/ Communication Concerns	Impacts to Private Property	Timeline of Project	Other	
264	South Coast Bikeway Alliance	Yes	11/9/2019	Website					X		X																					X	Any contemplated replacement of the Bourne and Sagamore bridges must prioritize excellent facilities for both pedestrians and cyclists to use the bridges as well as safe connections to the region's path and trail networksincluding the Cape Cod Canal Recreation Paths along both sides of the Cape Cod Canal. The facilities for cyclists and pedestrians on the existing bridges is unacceptable and treacherous and severely limits connectivity for the neighborhoods and communities in Bourne and Sandwich along the Cape Cod Canal.
265		Yes	11/9/2019	Website							X																						Bridge replacement improvement should include state of the art infrastructure for cyclists and pedestrians as well as improved access for both.
266		Yes	11/9/2019	Website			X																										i also had a crazy idea of building a tunnel as we alway joke about getting a permit but if you could have a entrance and exit at the big curve on rt. 25 where it's closets point to to canal by the power lines.cross over would be between the two bridges. and have it exit and enter at the rt. 3 where the power lines cross rt.3. this would cut down on tragic along the canal.
267		Yes	11/9/2019	Website						X	X	X							X			X											I DISapprove of adding vehicle lanes on the bridges to access Cape Cod. The current bridges act to deter visitors to this already over-crowded sandbar. The ecology of the cape cannot sustain even its present numbers. We need to invest in infrastructure that is less polluting; public transportation, electric buses, trains, and ferries from Bourne and surrounding communities will spread the environmental burden and commercial gains. There should be freight by water from New Bedford to the islands. The ecology of the cape is fragile and the natural landscape is the lure to this area. We don't want to destroy its beauty with more air and water pollution than is currently underway. Please find a non-polluting, ecologically sound way to improve the bridges. Adding a bike/pedestrian land is beneficial. What about HOV, express bus lanes or moving barriers to create 3 lanes on and 1 lane off-cape to begin weekends then reverse to facilitate off-cape traffic at the end of each weekend. Please coordinate with the upper cape towns for a comprehensive regional plan.
268		Yes	11/9/2019	Website							X																X						As a resident and business owner in Bourne it is imperative that pedestrian and cycle access be a key planning item for this project. The ability to safely travel across the canal to downtown Buzzard's Bay is greatly needed in order to help this town continue to flourish and grow.
269		Yes	11/9/2019	Website			X																										i would like to correct a idea about making a tunnel in my last comment. i meant to say make an entrance and exit ramp on rt 25 on the curve near the power lines and follow the power lines across the canal into sandwich where the power line crosses rt. 6 where to exit ramp and enter on the cape side. call it the rt 25 to rt. 6 cross over.if not a tunnel maybe put the new bridge there.it would be between the two bridges.
270	Friends of Mattapoisett Bicycle and Recreational Path	Yes	11/9/2019	Website					X		X																						I am writing to express my hope that replacement bridges across the Cape Cod Canal will include thoughtful design for safe, pleasant, efficient facilities for bicyclists and pedestrians. More and better connectivity across the Canal, including connections to area walking and biking paths, will be good for residents and visitors to our area. I have seen that improved facilities for active transportation in my Town of Mattapoisett have lead to the increased walking and biking.
271		Yes	11/9/2019	Website						X	X													X									What about 2 new bridges. One for large vehicles(weight restricted) and one for automobiles and motorcycles. Neither of the new bridges would allow pedestrians or bicycles. One of old bridges could be used as a pedestrian, bicycle, and small motorbike bridge. The other old bridge next to the new commercial bridge could be used for automobiles only. Hopefully removing mixed vehicles and pedestrian and bikes from the new bridges will lower their costs.

TABLE OF PUBLIC COMMENTS FOLLOWING DRAFT MRER/EA PUBLICATION

Comment #	Affiliation	Add to Mailing List (Yes/No)	Comment Date	Comment Type	Comment Subject																												Specific Comments/Questions
					ALTERNATIVES							ENVIRONMENTAL CONCERNS									TRANSPORTATION					OTHER							
					Favor Replacement	Third Bridge	Tunnel	Fill Canal	MassDOT Alternatives	USACE Alternatives	Design Recommendations	Water Quality	T&E Species	Fisheries	Flood Zones/Flooding	Climate Change	Historical/Cultural Concerns	Recreation	Noise/Air Quality	Socioeconomics	Traffic Concerns	Transportation Technology	Tolls	Weight Restrictions/ Concerns	Marine Transportation Considerations	Evacuation Concerns	Safety Concerns	EIS / NEPA Process	Public Involvement/ Communication Concerns	Impacts to Private Property	Timeline of Project	Other	
272	South Coast Bikeway Alliance	Yes	11/10/2019	Website							X																						As an avid cycling tourist and member of a local bicycle transportation advocacy group I strongly encourage the Army Corps of Engineers to incorporate a bicycle/pedestrian passage lane on both bridges. Having ridden/walked my bicycle across both bridges at least a half dozen times I found it very intimidating due to the narrow, elevated, unprotected sidewalk provided on the south side of the Bourne Bridge and the north side of the Sagamore Bridge. I toured with my bicycle across the country in 1974 and more recently for a few weeks with my daughter on her cross country bike trip in 2018 during which I experienced the large number of cyclists on dedicated paths. The incorporation of bike/ped lanes on the bridges will compliment the work being done by the South Coast Bikeway Alliance and the Cape Cod advocacy groups to make the South Coast and Cape Cod a safe, national recognized bicycling destination that will benefit from the increased tourism revenue.
273		No	11/10/2019	Website					X													X											I am concerned about the lack of attention being paid to improving and increasing public transportation options in planning for new bridges. For example, bus lanes and increased, regular train service. Vast improvement is needed in these areas. Plus, it is no solution to enable greater numbers to travel to the Cape without improving local road infrastructure and public transportation, which is inadequate.
274		Yes	11/10/2019	Website																												X	As a homeowner in Barnstable Village, I use both bridges to commute to my primary residence in New Jersey. Having experienced the rebuilding of the former Tappan Zee Bridge in NY, I can attest to the monumental nature of the project that is being considered. I can also attest to the final results being worth it. Financially I am sure that only one of the bridges (if that) will be able to be rebuilt. If both bridges could remain open while a new Sagamore was being built along side the existing bridge, I feel that would be the optimum solution. It is vital for the welfare of all Cape Cod residents and visitors that both bridges are well maintained. The National Seashore is a treasure that can only be practically accessed by crossing a bridge. It is of national not just local interest to keep that access in a convenient, safe condition.
275		Yes	11/11/2019	Website							X											X											As a parent, educator, cyclist and advocate for a healthier sustainable Massachusetts I urge the designers for the bridge replacements to consider the following. For many reasons: health, safety, and environmental quality any cycle and pedestrian pathways on the bridges must connect to extending pathways from the entrances and exits on the bridges. It is essential that the project incorporate a regional consideration. Coordination with existing environmental and cycling groups will help with this concern.
276		Yes	11/11/2019	Website					X		X											X											Replacement of the Bourne and Sagamore bridges must prioritize excellent facilities for both pedestrians and cyclists to use the bridges as well as safe connections to the region's path and trail networks, including the Cape Cod Canal Recreation Paths along both sides of the Cape Cod Canal. This is necessary for recreation riders and commuters. Any and all bridge replacement should include state-of-the art facilities for pedestrians and cyclists on the bridges as well as providing substantially improved access to the bridges for both pedestrians and cyclists. The U.S. Army Corps of Engineers and other stakeholders should prioritize safe bike and pedestrian infrastructure that directly links the new bridges to the Cape Cod Canal Recreation Path on both sides of the Canal.
277		Yes	11/11/2019	Website							X																						Is there any way to keep old bridges and transform into bike/pedestrian only? I have seen this done in other places (like the Walnut St Bridge in Chattanooga TN, and it becomes such an added feature.

TABLE OF PUBLIC COMMENTS FOLLOWING DRAFT MRER/EA PUBLICATION

Comment #	Affiliation	Add to Mailing List (Yes/No)	Comment Date	Comment Type	Comment Subject																												Specific Comments/Questions
					ALTERNATIVES							ENVIRONMENTAL CONCERNS									TRANSPORTATION					OTHER							
					Favor Replacement	Third Bridge	Tunnel	Fill Canal	MassDOT Alternatives	USACE Alternatives	Design Recommendations	Water Quality	T&E Species	Fisheries	Flood Zones/Flooding	Climate Change	Historical/Cultural Concerns	Recreation	Noise/Air Quality	Socioeconomics	Traffic Concerns	Transportation Technology	Tolls	Weight Restrictions/ Concerns	Marine Transportation Considerations	Evacuation Concerns	Safety Concerns	EIS / NEPA Process	Public Involvement/ Communication Concerns	Impacts to Private Property	Timeline of Project	Other	
278		Yes	11/11/2019	Website	X																						X						In 2013 I was a college student and lived on pizza and ramen. One of my favorite spots to get pizza for lunch was Sweet Tomatoes in Sandwich, near the Sagamore Bridge. One day I went in for lunch and the store was closed. The news broke that co-owner Michael Furlong, 43, was struck by a merging, eastbound vehicle on the approach for the bridge. His car was forced across the double yellow where it collided head-on with westbound traffic. He and the westbound driver were killed. The canal bridges are dangerous, damaging the Cape Cod Community and must be replaced.
279	Town of Bourne Select Board Member	Yes	11/12/2019	Website					X											X												X	As a member of the Select Board in the town of Bourne, it is with equal parts enthusiasm and concern that I anticipate replacing the two Cape Cod Canal bridges with a long-term solution that will benefit not only our residents and visitors but also the entire Cape Cod Canal area. The key is for all stakeholders to develop an effective partnership in which everyones goals, concerns, compromises, etc., can be given proper vetting and consideration. Bourne is in the midst of a town-wide economic initiative that will determine our ability to generate sufficient revenue to support our infrastructure. Bourne has suffered for decades following the completion of Route 25 to the Bourne Bridge in the early 1980s. We cannot afford to go backward. The antiquated bridges contribute, certainly, to our traffic woes, but the real source of these problems is the rotaries and roads leading to and from the bridges. It appears that the design for the two bridges will accommodate all types of traffic: motor vehicle, bicycle and pedestrian. However, the state and federal agencies must work together, during bridge construction and through adjustments to surface roads, to reduce the jams that plague local transportation and people simply passing through the area. Bourne alone will be the host location of the construction sites. The surface roads in the area leading up to and away from the bridge areas will be disrupted and normal commerce in the area will be adversely affected. It is our expectation that the pre-construction planning will include solutions to minimize the impact that may be affected by road reconfiguration outcomes. This may include short-term (temporary) solutions during construction. Eminent domain takings will likely play a major part of the long term solutions. These transactions must be equitable. We must show compassion for those losing their homes and other property, and offer assistance with transition. We must ensure that property values in affected neighborhoods do not decline.Ultimately, if the completion of the bridge construction and area surface roads relieves the stress that we all feel having to traverse the bridges to engage in commerce and meet daily obligations, it will be a project well done. We must learn to embrace traffic and the opportunities that come with it. But we must also minimize and overcome the negative consequences.
280		Yes	11/12/2019	Website					X		X										X	X											I am concerned that the plans offered do not account for any public transport or other HOV access to the Cape and Islands. Relying on private car transport to the Cape is outdated and at odds with MASS DOT plans to increase the sustainability of our transportation system and meet emission goals. It will likely also result in more car traffic on the cape as increased access to private vehicles will lead to more people driving here. Please consider a more comprehensive, sustainable and flexible approach.
281		Yes	11/12/2019	Website						X											X	X											I would like to see money spent on public transportation on the Cape to make it more accessible and possible to be there without a car. Driving around in traffic is not a pleasant way to spend your vacation and I think people would appreciate having other options. I would not support spending money on bigger bridges to make it easier for more people to drive to the Cape.

TABLE OF PUBLIC COMMENTS FOLLOWING DRAFT MRER/EA PUBLICATION

Comment #	Affiliation	Add to Mailing List (Yes/No)	Comment Date	Comment Type	Comment Subject																												Specific Comments/Questions
					ALTERNATIVES							ENVIRONMENTAL CONCERNS									TRANSPORTATION					OTHER							
					Favor Replacement	Third Bridge	Tunnel	Fill Canal	MassDOT Alternatives	USACE Alternatives	Design Recommendations	Water Quality	T&E Species	Fisheries	Flood Zones/Flooding	Climate Change	Historical/Cultural Concerns	Recreation	Noise/Air Quality	Socioeconomics	Traffic Concerns	Transportation Technology	Tolls	Weight Restrictions/ Concerns	Marine Transportation Considerations	Evacuation Concerns	Safety Concerns	EIS / NEPA Process	Public Involvement/ Communication Concerns	Impacts to Private Property	Timeline of Project	Other	
282		Yes	11/12/2019	Website																		X					X						Any reconstruction of the bridges would do well to ensure that ample considerations are made for improving transit connectivity and bike/pedestrian safety. Bus lanes are a prime example - they offer an easy way to move more people with less space, which could reduce costs for the bridges - ideally, we don't need to increase the number of lanes, just increase the number of people per vehicle.
283		Yes	11/13/2019	Website					X		X										X	X											the Cape has enough motor vehicle traffic, too much traffic, dangerous traffic and none of the urban infrastructure to safely handle the existing traffic flow. The Cape is mostly rural - please keep it that way. Invest in public transportation, bicycle lanes and walking pathways. Please leave your 1950's Eisenhower building roads for cars behind and invest in a sustainable community building future. Take down a bridge, put in a commuter rail, (remember there use to be one), public transportation and bike lanes on all state roadways.
284		Yes	11/13/2019	Website					X	X						X						X											The billion dollars that will go into these bridges should be spent to expand public transportation powered by renewable energy sources. Making it easier for more cars to get to the Cape is a step back into the 20th C. instead of recognizing the drastic changes we have finally seen in our climate in the 21st. C, PLEASE be part of our national effort to reduce greenhouse gasses in every way possible starting NOW!! I want my grand-children to be left a planet they can survive in! If you go ahead you may find Extinction Rebellion takes action to stop it. And many other concerned citizens will join them. Do the right thing, help save our planet.
285		No	11/13/2019	Website							X																						1. I would prefer Alternative D . 2. I do bike the canal service road, and would hope that you can keep it open as much as possible. 3. I hope that you can raise the bridge clearances to allow lager vessels thru the canal. 4. Since the bridges will be built to modern standards, I would like to see a modern type design. (cable stayed, etc.) 5. With increased volume attainable on the bridges, the approaches must be included in the project. (by the state I assume)
286		No	11/13/2019	Website							X											X											Please consider public transportation priorities in the replacement of the cape bridges. Train and bus transportation should be prioritized to incentivize access to the cape without a car. Additionally, please be sure that the space dedicated to the pedestrian and bike access is wide enough for safe and comfortable passage. These bridges could become a tourism location in themselves, so the pedestrian areas should factor in congestion. Finally, please remember that these bridges will be on the landscape for decades, so please make them beautiful as well as functional- not just utilitarian concrete and steel.
287		Yes	11/13/2019	Website					X							X						X											I urge efforts to rehabilitate the Bourne and Sagamore bridges to focus on opportunities to decrease carbon emissions associated with travel to the Cape, for example, by emphasizing public transportation rather than merely increasing bridge capacity. Focusing on increasing bridge capacity to handle more automobile traffic is merely inviting yet more automobile travel and more emissions.

TABLE OF PUBLIC COMMENTS FOLLOWING DRAFT MRER/EA PUBLICATION

Comment #	Affiliation	Add to Mailing List (Yes/No)	Comment Date	Comment Type	Comment Subject																												Specific Comments/Questions
					ALTERNATIVES							ENVIRONMENTAL CONCERNS									TRANSPORTATION					OTHER							
					Favor Replacement	Third Bridge	Tunnel	Fill Canal	MassDOT Alternatives	USACE Alternatives	Design Recommendations	Water Quality	T&E Species	Fisheries	Flood Zones/Flooding	Climate Change	Historical/Cultural Concerns	Recreation	Noise/Air Quality	Socioeconomics	Traffic Concerns	Transportation Technology	Tolls	Weight Restrictions/ Concerns	Marine Transportation Considerations	Evacuation Concerns	Safety Concerns	EIS / NEPA Process	Public Involvement/ Communication Concerns	Impacts to Private Property	Timeline of Project	Other	
288		Yes	11/13/2019	Website							X					X	X				X	X											1: Where is all the added traffic going to go once it crosses the bridge? There is only so much room on the cape. and it seems like this will only put more pressure on our communities limited parking resources. 2: Why are there no train tracks running down the middle of either of these bridges?? As you know, the elevated train bridge is from the same vintage as these two bridges and is clumsy and, I assume, practically obsolete. It seems like a stupid oversight not to include mass transit in this plan especially considering the fact that cars represent such a large contributor to green house gasses and climate change. It is not enough to say that buses will be able to use the bridge; we need commitment to rail. 3: It seems unfortunate to loose both of these historically important structures. Is there any plan to save parts of either bridge for posterity? In general, I think this solution was arrived at in a vacuum that didn\'t take into consideration the tenuous state of our island with regards to climate change, lack of public transit and the evolution of public opinion with regards to transportation. -- Train ridership is up this year - Acela is up by 4%. Let's build rail into the plan NOW so that we aren't, again, having to be reactive down the line rather than proactive.
289		Yes	11/13/2019	Website			X																										Would a tunnel be feasible? I'm pretty sure that the technology is there.
290		Yes	11/13/2019	Website					X												X	X											As a frequent Cape visitor during the summer months I am confident that any increased capacity will induce more demand to travel. As is the case with most road widening, the benefit is short-lived and continues to prioritize the automobile over other modes of getting around. Perhaps a dedicated bus lane or rail right-of-way might do more to ease the congestions woes of our favorite local peninsula.
291		No	11/13/2019	Website					X	X												X											If we're undertaking a new project to build new bridges those bridges should be primarily focused on sustainable transportation methods like walking, biking, bus and rail. We should not increase the number of lanes for automobiles but should increase the space for public sustainable transportation methods like the ones listed above.
292		Yes	11/13/2019	Website												X					X	X											I am very much opposed to the building of new bridges. They would encourage a lot more traffic to the Cape and cause more congestion. This is the opposite of our goals of reducing road traffic as an important step in reducing carbon in the atmosphere. We are at an extreme crisis point with climate change. DON'T TAKE US IN THE OPPOSITE DIRECTION!!!!
293		No	11/13/2019	Website					X	X						X					X	X											If the bridge is reliable and safe, I believe it is a bad choice to rebuild a bigger bridge to allow more traffic flow . This is definitely going to have a negative impact on the Cape Cod. We underestimate the potential pollution caused by vehicles . I would like to dispute the thought that bigger bridge means less travel times to Cape due to less congestion. But this is not true. Currently majority of the population skips traveling to Cape because of the traffic, with a bigger bridge and less travel times more and more people will be traveling by car there. In order to promote tourism, the right choice is to introduce alternate modes of transportation like high speed trains from Boston and other suburbs. Also, when the bridge reaches a stage which causes safety concern, the bridge can be replaced by a wider bridge, but with same number of car lanes, and the extra lanes for buses and trains.
294		Yes	11/13/2019	Website												X																	I am writing to oppose replacing the Sagamore Bridge. I have made many trips over this bridge, and while it can back up with traffic, I find I can adjust my travel time accordingly. Given the fragility of our environment and global warming, I fear that widening the bridge will only encourage more travel on to Cape Cod by car, and will only add to further deterioration of our environment.

TABLE OF PUBLIC COMMENTS FOLLOWING DRAFT MRER/EA PUBLICATION

Comment #	Affiliation	Add to Mailing List (Yes/No)	Comment Date	Comment Type	Comment Subject																												Specific Comments/Questions
					ALTERNATIVES							ENVIRONMENTAL CONCERNS									TRANSPORTATION					OTHER							
					Favor Replacement	Third Bridge	Tunnel	Fill Canal	MassDOT Alternatives	USACE Alternatives	Design Recommendations	Water Quality	T&E Species	Fisheries	Flood Zones/Flooding	Climate Change	Historical/Cultural Concerns	Recreation	Noise/Air Quality	Socioeconomics	Traffic Concerns	Transportation Technology	Tolls	Weight Restrictions/ Concerns	Marine Transportation Considerations	Evacuation Concerns	Safety Concerns	EIS / NEPA Process	Public Involvement/ Communication Concerns	Impacts to Private Property	Timeline of Project	Other	
295		No	11/13/2019	Website																	X												As a transportation planner, now retired from the City of Cambridge, I am well aware that expanding roadway capacity on the canal bridges would be a disaster--it would increase traffic, increase delays, and the impact to these would be felt throughout the Cape. We never seem to learn the lessons that increased capacity consistently teach--that it backfires.
296		No	11/14/2019	Website	X						X											X	X										Please take into account the long-term environmental consequences. I'm in favor of replacing the bridges and would recommend a toll for cars that helps pay for public transportation that is more environmentally friendly.
297		Yes	11/14/2019	Website					X	X	X											X											The proposed design for replacement of aging bridges does not adequately meet the needs of either the residents of the Cape, the interests of the State of MA, or the protection of natural resources in the region. We can do so much better in the Cape Cod bridges to address public transit needs and to design for reduction of air pollution and coastal habitat loss. I very very rarely have a serious slow down commuting across the Bourne, but am very frustrated by the lack of more public transit options to go off and on Cape. Dedicated bus /shuttle lanes and off cape parking are a critical need. I am also uncomfortable with lane safety on the bridges because currently they are too narrow, have no divider for oncoming traffic and not even a small shoulder. Widening to address safer transit is good, but there is no need for more than two lanes or more speed in a safety redesign. The backups only occur on weekends in the summer-- but the goal should be moving the people, not more vehicles. Making it easier to move vehicles during those short times will result in even more cars and parking lots and air and water pollution on cape. Some cities and vacation places have already decided to restrict visitor numbers and cars to save their character and environment. Our bridge design should retain its role of a funnel, not an open faucet and support the regional plans for reducing storm water runoff, vehicle pollutants, and other detrimental human impacts on cape while having a walkable, bike able, and transit friendly future.
298		Yes	11/14/2019	Website																												X	The present bridges are more than adequate. Please to not rebuild them. Allow the Cape to be as it is now. I understand that this bridge building will have a negative impact on our environment, and a possible negative impact on Cape Cod.
299		Yes	11/14/2019	Website												X																	Please do not add additional capacity on this bridge. It will only induce more travel, which causes the climate crisis we are currently experiencing. We are in the middle of a mass extinction event and scientists have given us 10 years to stop it, or we risk the collapse of the ecosystems that feed us and the flooding of most major cities on the coasts. Please, for the love of god, do not make more people drive their cars onto the Cape. I have been visiting family there for my entire life and I will gladly sacrifice a modern bridge if it means saving this planet for my children and there's. Please have the compassion to look at what is going to happen to our friends and family if we do not stop emitting carbon. Please.
300		Yes	11/14/2019	Website	X																						X						I am a south shore resident who commutes to Pocasset for work over the Bourne Bridge and plan to for the next several years. I fully and enthusiastically approve of new bridges for Cape Cod. Infrastructure does not last forever, and as the population and economy grows, safe and reliable bridges are paramount. Modern infrastructure will also help, I trust, with traffic and allowing emergency vehicles to pass. I'm looking forward to a median in the bridges and wider lanes. They lanes are simply too narrow and unsafe, especially at night in rain or snow, and I feel unsafe every time I cross the bridge.

TABLE OF PUBLIC COMMENTS FOLLOWING DRAFT MRER/EA PUBLICATION

Comment #	Affiliation	Add to Mailing List (Yes/No)	Comment Date	Comment Type	Comment Subject																												Specific Comments/Questions
					ALTERNATIVES							ENVIRONMENTAL CONCERNS									TRANSPORTATION					OTHER							
					Favor Replacement	Third Bridge	Tunnel	Fill Canal	MassDOT Alternatives	USACE Alternatives	Design Recommendations	Water Quality	T&E Species	Fisheries	Flood Zones/Flooding	Climate Change	Historical/Cultural Concerns	Recreation	Noise/Air Quality	Socioeconomics	Traffic Concerns	Transportation Technology	Tolls	Weight Restrictions/ Concerns	Marine Transportation Considerations	Evacuation Concerns	Safety Concerns	EIS / NEPA Process	Public Involvement/ Communication Concerns	Impacts to Private Property	Timeline of Project	Other	
301		Yes	11/14/2019	Website	X																												I fully endorse the US Army Corps of Engineers, New England District in their execution and implementation of new Bourne and Sagamore Bridges for the Cape and Islands. As a Bourne resident and being almost as old as the bridges, it's paramount that this study takes place and that the bridges be replaced.
302		Yes	11/14/2019	Website												X										X						X	What an environmental disaster this would be. Does the cost of the new bridges include the cost of removing the old ones? FACT: Evacuation from the Cape is not now possible, nor will it be with new bridges. Please be realistic. and as far as the residents along the canal - well let the lawsuits begin.
303		No	11/14/2019	Website							X																						I would love to see a bicycle lane on both new bridges crossing the Cape Cod canal.
304		Yes	11/17/2019	Website						X	X																		X	X			After attending the first public forum at Bourne High, it became painfully apparent that the rigid process being used serves as a mechanism to ignore the direct impact on private citizens and property owners impacted in the zones the new bridges would be constructed. This process means that the concerns raised about bridge replacement impacts have no bearing on whether to build a bridge or to do something different. The process will only include their concerns once it has been decided that the bridges are going to be built, which then means the discussion with these individuals is now merely about how it impacts them, not about whether or not the impact on them could\'ve been prevented in the first place. I, like most, wholeheartedly agree that the bridges need replacement. And there is no one plan that is \correct\" any course of action will have some kind of negative impact. The decision making process should weigh the long-term and short-term impacts of various scenarios and favor a plan which may incur short-term pain if it means lesser long-term impacts. The current plan that is being promoted (the largest of the options) will provide two fantastic bridges up to modern standards but they absolutely will impact private land owners surrounding the bridges some of whom have owned these waterfront properties for generations. I'm wondering why what seems to me like an obvious path didn't even seem to be considered. It seems plausible that you could construct one or two low temporary bridges with just enough clearance to allow most small to medium sized pleasure craft and small commercial vessels (fishing boats etc) to pass underneath. Larger commercial traffic would need to divert around Cape Cod for the duration of construction. Once the temporary bridge(s) are open the current bridges could be torn down and replaced inside their current footprint preventing the need to impact adjacent private land owners or surface road re-routing. In this scenario the primary pain point would impact commercial shipping traffic on a temporary basis for a few years while the bridges are replaced in-place. Traffic would be impacted as traffic would need to route to the temporary bridges but we would still have two open bridges at all times. This incurs some short-term pain but once completed it has the least land-owner & existing infrastructure/surface roads impacts.

TABLE OF PUBLIC COMMENTS FOLLOWING DRAFT MRER/EA PUBLICATION

					Comment Subject																												
					ALTERNATIVES							ENVIRONMENTAL CONCERNS									TRANSPORTATION					OTHER							
Comment #	**Affiliation**	**Add to Mailing List (Yes/No)**	**Comment Date**	**Comment Type**	**Favor Replacement**	**Third Bridge**	**Tunnel**	**Fill Canal**	**MassDOT Alternatives**	**USACE Alternatives**	**Design Recommendations**	**Water Quality**	**T&E Species**	**Fisheries**	**Flood Zones/Flooding**	**Climate Change**	**Historical/Cultural Concerns**	**Recreation**	**Noise/Air Quality**	**Socioeconomics**	**Traffic Concerns**	**Transportation Technology**	**Tolls**	**Weight Restrictions/ Concerns**	**Marine Transportation Considerations**	**Evacuation Concerns**	**Safety Concerns**	**EIS / NEPA Process**	**Public Involvement/ Communication Concerns**	**Impacts to Private Property**	**Timeline of Project**	**Other**	**Specific Comments/Questions**
305		Yes		Website					X	X	X										X	X											I commend to you the Oct 30, 2019 report by Eve Zuckoff broadcast on WCAI, as a superb summary of my concerns regarding the Army Corps of Engineers proposals to replace both Cape Cod Canal bridges with 6 lane bridges that may actually increase the maximum traffic flow onto the Cape by 25% per hour. This increased ease of driving onto the Cape primarily in privately owned vehicles would be in direct conflict with many of the important goals worked out thoughtfully and described carefully in the Cape Cod Commission Regional Transportation plan. These goals are detailed in the Cape Cod 2020 Regional Transportation Plan for 2020-2040. This plan was endorsed July 15, 2019. Rather than addressing the impact of possible increased local traffic congestion which would then flow onto local roads such as 6A and Rt 28 among others, and resulting safety and environmental impacts, the Army Corps of Engineers plan prioritizes increased vehicular traffic flow onto the Cape. This increased traffic flow may well overwhelm the already precarious environmental infrastructure issues of water quality and climate change on Cape Cod. The Regional Transportation Plan, in contrast, appropriately prioritizes multimodal transit, including cycling and pedestrian travel, and mass transit- both increased rail and bus options both to and from the Cape and within the Cape itself. The survey results from Cape residents support those priorities. By facilitating an enormous increased traffic flow onto the Cape year round- we risk making the Cape uninhabitable for everyone- sooner rather than later. How much more sensible would it be to instead carefully consider all the issues examined by the Regional Transportation Plan and decide whether a $1 Billion transportation investment should be better allocated to a mix of improved rail and electric bus transit, long term parking both on and off the Cape, and more park and ride lots which along with improved public mass transit could allow increased travel efficiency while bringing down the travel carbon footprint with fewer, rather than more individual vehicles on the Capes roads. After arriving at their destinations, the holiday and seasonal visitors could be supported by increased and improved local transit which might include electric car-share options. I oppose the Army Corps of Engineers plan to build two 6 lane bridges to replace the current Bourne and Sagamore Bridges at this time

TABLE OF PUBLIC COMMENTS FOLLOWING DRAFT MRER/EA PUBLICATION

					Comment Subject																												
					ALTERNATIVES							ENVIRONMENTAL CONCERNS									TRANSPORTATION					OTHER							
Comment #	Affiliation	Add to Mailing List (Yes/No)	Comment Date	Comment Type	Favor Replacement	Third Bridge	Tunnel	Fill Canal	MassDOT Alternatives	USACE Alternatives	Design Recommendations	Water Quality	T&E Species	Fisheries	Flood Zones/Flooding	Climate Change	Historical/Cultural Concerns	Recreation	Noise/Air Quality	Socioeconomics	Traffic Concerns	Transportation Technology	Tolls	Weight Restrictions/ Concerns	Marine Transportation Considerations	Evacuation Concerns	Safety Concerns	EIS / NEPA Process	Public Involvement/ Communication Concerns	Impacts to Private Property	Timeline of Project	Other	Specific Comments/Questions
306		Yes		Website					X		X					X						X					X						I reside in Falmouth and am a member of the board of the Friends of the Falmouth Bikeway. As you probably know, Falmouth and Bourne are working very hard to link the Sea to Shining Sea multi-use path to the Cape Cod Canal multi-use path. Direct access to well-marked, separated multi-use paths on both the Sagamore and Bourne Bridges from the Canal path is of major importance to the large community of bikers, hikers, joggers, parents pushing carriages, dog walkers, skate boarders, etc. that utilize existing multi-use paths on Cape Cod. Whether the ultimate decision is to build new replacement bridges or renovate the existing bridges the final result in either case should incorporate paths on each side of each of the bridges with separation from motor vehicle traffic due to the danger of strong winds along the Canal potentially blowing riders into motor vehicle lanes. The current sidewalks on the bridges are functionally obsolete due to the lack of safety features to separate foot and bicycle traffic from motor vehicles. The present setup does not allow bikers to ride over the bridges - they must walk their bikes across due to safety issues. These bridges, in whatever form they emerge, should be constructed with a vision toward the future with access to all modes of transportation including environmentally friendly ones. They should also be built to encourage all members of the public to pursue safe forms of physical fitness in beautiful panoramic settings that will arise from well-planned bridges. We have one chance to \get it right\" for the next 100 years. Numerous European countries have demonstrated that beautiful and safe multi-use paths can be seamlessly melded into their transportation system. We should do the same with the new Bourne and Sagamore Bridges. Oh and by the way please keep those names for the new bridges - we have too many other public projects named after politicians.
307		Yes		Website					X		X											X											Any contemplated replacement of the Bourne and Sagamore bridges must prioritize excellent facilities for both pedestrians and cyclists to use the bridges as well as safe connections to the region's path and trail networks including the Cape Cod Canal Recreation Paths along both sides of the Cape Cod Canal. The facilities for cyclists and pedestrians on the existing bridges is unacceptable and treacherous and severely limits connectivity for the neighborhoods and communities in Bourne and Sandwich along the Cape Cod Canal.

TABLE OF PUBLIC COMMENTS FOLLOWING DRAFT MRER/EA PUBLICATION

Comment #	Affiliation	Add to Mailing List (Yes/No)	Comment Date	Comment Type	Comment Subject																												Specific Comments/Questions
					ALTERNATIVES							ENVIRONMENTAL CONCERNS									TRANSPORTATION					OTHER							
					Favor Replacement	Third Bridge	Tunnel	Fill Canal	MassDOT Alternatives	USACE Alternatives	Design Recommendations	Water Quality	T&E Species	Fisheries	Flood Zones/Flooding	Climate Change	Historical/Cultural Concerns	Recreation	Noise/Air Quality	Socioeconomics	Traffic Concerns	Transportation Technology	Tolls	Weight Restrictions/ Concerns	Marine Transportation Considerations	Evacuation Concerns	Safety Concerns	EIS / NEPA Process	Public Involvement/ Communication Concerns	Impacts to Private Property	Timeline of Project	Other	
308		Yes	11/14/2019	Website	X											X				X			X										I have been a homeowner and year-round resident of Falmouth since 1991, and also started a Falmouth-based company that year that I still own and operate as my main source of income. Based on my current understanding, Alternative D (four lane plus 2 aux lanes) seems like the best overall investment. Though the economic benefit analysis suggests this is not as favorable as Alternative C, it seems to me that the full consideration of issues such as regional resilience and safety tips the scale in favor of Alternative D, especially in view of the modest incremental cost. One of the biggest concerns seems to be that upgrading the bridges will put undue pressure on the Cape because it would facilitate increased use, and potential abuse, of the resources there. It may be worth considering setting up a toll system that will collect funds from the use of the bridges to support activities that will directly address these issues. For example, support for: -towns that engage in forward-thinking projects to minimize the footprint of residents and visitors on fragile resources -regional resiliency planning -environmental preservation and restoration projects -enforcement of regulations that enable and ensure the above. Massachusetts already manages a variety of roadway tolls and would likely be able to integrate new toll points into the system. Residents and businesses could be provided favorable rates for unlimited trips, and users for whom a toll would present an undue hardship (eg low wage workers who must use the bridge for transport to and from work, or small businesses that frequently use the bridge) could be offered subsidies.
309		Yes	11/14/2019	Website					X	X											X	X											We need LESS private vehicular traffic on the Cape in the summer and at rush hour. Increasing private vehicle capacity will make a bad situation even worse. Please go back to the drawing board and work with the Cape community to create plan that reduces the already burdensome overuse of private vehicles.
310		Yes	11/14/2019	Website					X	X	X										X	X											I want to urge the planners of the next bridge to include space for public transit on the bridge, that is, a space separate from car lanes for a dedicated bus line, a train line, or a tram or trolley. I live near the Hudson River in NY State and thought it was extremely shortsided for the replacement for the Tappan Zee to NOT include a train lane, even though this was recommended by various parties. Allowing more and easier mass transit to the Cape will help reduce car traffic on the Cape and is therefore highly worthwhile.
311		Yes	11/14/2019	Website					X	X	X										X	X											I am opposed to the idea of bringing more people onto the cape without addressing the obvious failures in our public transit system. The Cape Flyer doesn't run year round, and only stops in Hyannis once on the Cape. This including our aquifer is already overtaxed. Before anything is done with the bridges discourages anyone from taking the Cape Flyer if the destination is the upper Cape. It makes little sense to have the stop for the upper Cape be on the other side of the bridge in Bourne which does nothing to reduce traffic coming over the bridge. This is just one example. There is no transit on the northside of the cape from Sandwich through Brewster on 6A. There is no bike path on 6A. The bike path on the canal does not connect to Sandwich village. As a local realtor, I see the results of increased congestion and traffic on a regular basis. Bringing more people on the Cape faster is not the answer (and yes, I do think that more will come if the traffic is lighter going over the bridge - look at the Big Dig in Boston). My husband sits in that traffic on his commute to Boston for work. Our roads were not designed to handle the level of traffic that this would bring and our infrastructure I believe that a good hard look at public transit bike paths

TABLE OF PUBLIC COMMENTS FOLLOWING DRAFT MRER/EA PUBLICATION

Comment #	Affiliation	Add to Mailing List (Yes/No)	Comment Date	Comment Type	Comment Subject																												Specific Comments/Questions
					ALTERNATIVES							ENVIRONMENTAL CONCERNS									TRANSPORTATION					OTHER							
					Favor Replacement	Third Bridge	Tunnel	Fill Canal	MassDOT Alternatives	USACE Alternatives	Design Recommendations	Water Quality	T&E Species	Fisheries	Flood Zones/Flooding	Climate Change	Historical/Cultural Concerns	Recreation	Noise/Air Quality	Socioeconomics	Traffic Concerns	Transportation Technology	Tolls	Weight Restrictions/ Concerns	Marine Transportation Considerations	Evacuation Concerns	Safety Concerns	EIS / NEPA Process	Public Involvement/ Communication Concerns	Impacts to Private Property	Timeline of Project	Other	
312		Yes	11/14/2019	Website						X										X	X						X	X		X			THE NEW CANAL BRIDGES RECOMMENDED CLEARLY NEED AN ENVIRONMENTAL IMPACT STATEMENT. The study takes a good look at the crossing alternatives and focuses well on the engineering, bridge environs and tourist benefits. However, its Environmental Impact Assessment variously dismisses or avoids fundamental broader Cape-wide social and economic issues without specific analysis. The most important impact question is side-stepped: the affect on the people who live and work on the Cape. A key assumption, stated in places, is that because it is a replacement project, there will not be a significant Cape-wide environmental impact. That is potentially valid until the recommendation is made. That is for bridges with more than double the size and capacity of the present ones, yet the report never recognizes or addresses how this completely changes the analysis that is needed. In terms of peak capacity, the Option D proposed is equivalent to building approximately five bridges of the size we have now. It is know that the primary reason we have a shortage of affordable housing on Cape Cod is competition from off-Cape for second (third, fourth, etc.) homes and private and commercial rentals. (The income disparity issue is likely next). For the Sagamore Bridge, the recommended solution (option D) more than doubles the hourly capacity for traffic to reach the Cape from Rte 3, and it similarly increases the capacity from Rte 25 on the Bourne Bridge. When weekend access from all around is made much easier for many thousands of people, house prices could easily skyrocket. If so, more small affordable houses will be torn down and replaced with bigger second homes. More than twice as many cars visiting on summer weekends may also lead to traffic gridlock in places beyond the near-bridge towns, and substantially increased pressure on our fragile natural environment. House price acceleration may begin as soon as the decision is made, if it is for Option D, well before bridge construction starts. Environmental Impact Evaluations and Assessments are not intended to only cover recreation and natural resources. They are first intended to focus on the human economic and social environment. This report's assumption in recommending skipping a full EIS is that replacement bridges only need a cursory analysis - a few more cars can only be good for commerce, so no need to look at any more details. A Finding of No Significant Impact" may be fine if 'Option D' is not recommended. Option D involves a huge change to traffic capacity that has the potential for very significant Cape-wide impacts.
313		Yes		Website	X															X	X												As a private citizen and a business owner with locations in Chatham and the Outer Cape (Eastham, Wellfleet, Provincetown), I enthusiastically support the potential rebuild of the Sagamore bridge. There are numerous reasons why I support this project. To name a few: safety, traffic relief, and easier access to all the great things Cape Cod has to offer. In addition, it is very difficult and costly to transport goods off and on to the Cape with the current restrictions due the inadequate bridge system. This makes it harder to do business on Cape Cod thus limiting potential jobs and driving up the costs of goods. we should be able to travel off and on the Cape without concern of major congestion whether it is mid-summer or the dead of winter.

TABLE OF PUBLIC COMMENTS FOLLOWING DRAFT MRER/EA PUBLICATION

Comment #	Affiliation	Add to Mailing List (Yes/No)	Comment Date	Comment Type	Comment Subject																												Specific Comments/Questions
					ALTERNATIVES							ENVIRONMENTAL CONCERNS									TRANSPORTATION					OTHER							
					Favor Replacement	Third Bridge	Tunnel	Fill Canal	MassDOT Alternatives	USACE Alternatives	Design Recommendations	Water Quality	T&E Species	Fisheries	Flood Zones/Flooding	Climate Change	Historical/Cultural Concerns	Recreation	Noise/Air Quality	Socioeconomics	Traffic Concerns	Transportation Technology	Tolls	Weight Restrictions/ Concerns	Marine Transportation Considerations	Evacuation Concerns	Safety Concerns	EIS / NEPA Process	Public Involvement/ Communication Concerns	Impacts to Private Property	Timeline of Project	Other	
314		Yes	11/15/2019	Website					X	X						X						X											The report does not address climate change and this makes it seriously lacking. This is an opportunity for us to build replacements for the bridges that would accommodate public transit options such as trains to reduce traffic. We need to look at innovative ways to reduce our carbon dioxide output, re-envision these bridges, and put carbon emission goals in place for the Cape and Islands. This is our chance to be forward-thinking. Look at the section in the report on Climate -- all it mentions is the typical weather patterns! We can\'t bury our heads in the sand when it comes to climate change and its detrimental impacts to our economy, health, and welfare! We can do much better than this and engage the scientific community on the Cape in regard to climate goals that are necessary input.
315		Yes	11/15/2019	Website					X	X						X						X											I work for a design-build company on Martha\'s Vineyard called South Mountain Company. We build energy efficient homes and install solar-based systems. In all our work, we're looking toward the future and the legacy we leave behind for the island. This report needs to look at the current climate emergency we are in right now and design a bridge that will reduce our carbon footprint. This is our chance to address climate change and design accordingly to reduce traffic and increase public transportation options to the Cape.
316		Yes	11/15/2019	Website	X																												Please rebuild the bridges
317		Yes	11/15/2019	Website	X															X							X						I have personally spoken to a number of visitors that expressed similar sentiments regarding their journey to cape cod . The main concern is how narrow the present bridge is . One person went as far as to say navigating over the sagamore bridge is the most tense and fearful part of their commute . A bigger and safer bridge will most definitely bring more revenue to the cape and the islands in my opinion.
318		No	11/15/2019	Website					X	X	X					X			X			X											Please change your design for the proposed new bridges to include significant infrastructure for public transportation. The transportation sector makes up 42 percent of greenhouse gas emissions in Massachusetts. These emissions are the single greatest drivers of climate change. Massachusetts has a goal to reduce the number of cars on the road. The current proposal works against this goal by expanding capacity and not considering public transportation. We have the opportunity to rethink this..Please redesign these bridges with a commitment to increased public transportation with dedicated bus lanes and expanded rail service, which would help reduce the number of cars on the road and, in turn, carbon emissions. this is a once-in-a-lifetime opportunity to build a more sustainable future for the Cape.
319		Yes	11/15/2019	Website	X														X		X												I do realize the bridges need to be replaced. However, I believe if they are built to a much larger scale more traffic for daily beach visits will happen and that is not a good thing with the way people drive and trash places they frequent these days. When I walk my dog I have to have a puppy bag and a bag for trash and the vaping machine parts are really piling up. The Cape has plenty of places to overnight and needs to get back to a gentler way of summer life than we have been seeing with this past decade of more and more ugly McMansions, more and more boats and more and more craziness. At some point we have to maintain our infrastructure for what we are and stop aiding the eco unfriendly McMansion growth. (and their hurry up and get there lifestyle) That said, As an abutter to the survey area I would like the planners to push for dust control, traffic maintenance, and noise mitigation (reasonable hours of work) for the least disruption to the neighborhoods.
320		Yes	11/15/2019	Website					X	X	X								X			X											The plan for raising the number of lanes across the bridges is short sighted as it does not reserve the additional lanes for public transit. The easier you make it for cars to cross onto the Cape, you will just transfer the road jams onto the Cape itself, raising the level of pollution in the towns and sensitive habitat.

TABLE OF PUBLIC COMMENTS FOLLOWING DRAFT MRER/EA PUBLICATION

Comment #	Affiliation	Add to Mailing List (Yes/No)	Comment Date	Comment Type	Comment Subject																												Specific Comments/Questions
					ALTERNATIVES							ENVIRONMENTAL CONCERNS									TRANSPORTATION					OTHER							
					Favor Replacement	Third Bridge	Tunnel	Fill Canal	MassDOT Alternatives	USACE Alternatives	Design Recommendations	Water Quality	T&E Species	Fisheries	Flood Zones/Flooding	Climate Change	Historical/Cultural Concerns	Recreation	Noise/Air Quality	Socioeconomics	Traffic Concerns	Transportation Technology	Tolls	Weight Restrictions/ Concerns	Marine Transportation Considerations	Evacuation Concerns	Safety Concerns	EIS / NEPA Process	Public Involvement/ Communication Concerns	Impacts to Private Property	Timeline of Project	Other	
321		Yes	11/15/2019	Website					X												X											X	My only comment is that if or when the bridges are rebuilt or improved is that consideration is given to the increasing pressure on the infrastructure on Cape Cod. The roads in the Cape are already clogged with traffic in the summer and improved access to the Cape will automatically increase that pressure. You cannot improve access without improving the infrastructure and by infrastructure I mean the existing roads and wastewater treatment.
322		Yes	11/15/2019	Website													X				X												I realize that the bridges need to be replaced. I have two concerns. One is increased tourism, new and wider bridges would be great, more traffic capacity would not be great. The second would be to try to make the new bridges as graceful and beautiful as the current ones.
323		Yes	11/15/2019	Website					X		X							X				X	X									X	We are delighted to learn that new bridges will be built. The design is sound and the public comment process is fair. Our comments: - Please, build pedestrian and bike paths on BOTH sides! Walking and bicycles are means of transportation, just as motorized vehicles! Furthermore, it will be attractive to tourists to cross the canal by foot or bikes, thus increasing economic returns. On top of that, those are pure environmentally sound options. - Please, put a physical barrier to stop people from turning left on that Dunkin Donuts at Bourne! In fact, if it can at all be part of the plan, that space could be a nice Cape Cod Welcome Information Center. - Bridge fees: as residents, I would do not mind paying a small reasonable car bridge fee, either annually or with Ezpass if it helps maintain the structure. But most importantly, tourist paying the fees would be a significant source of funds for the Cape.
324		Yes	11/15/2019	Website					X	X	X																						I was at meeting in Hyannis and suggested a walkway on 2nd level above the center median but now have another idea to make it really unique: Make it double decked like the GWB in NYC BUT with only one direction on each level so it's thus a MUCH narrower bridge and might even somewhat resemble current ones. Have the upper level be the one going onto Cape so they have the best view and the lower level going off-Cape as most visitors hate to leave so not having as good view might be ok. You could then have a separate narrower path for pedestrians on upper level and bikes on lower one.
325		Yes	11/15/2019	Website	X															X							X						It has to happen! We need tourists to survive. We need a safe and affective bridge to allow access!
326		Yes	11/15/2019	Website					X	X	X										X	X					X						First, I urge that the bridges have only ONE lane in each direction. This is because if they have 2 lanes in each direction, then traffic may flow smoothly over the bridges, but there will be additional traffic, creating bad traffic jams on major highways on the mainland and/or the Cape. So 2-lane bridges won't solve the congestion problem. In addition, private cars are very serious causes of greenhouse-gas emissions and other pollution, and for that reason we need fewer rather than more cars driving to and from the Cape. In addition, I urge that along with rebuilding the bridges with only one lane, there also be massive improvements in public transportation to the Cape. Specifically, there should be much better rail service to Hyannis, along the lines of the Rail Vision transformations being discussed regarding the MBTA's commuter rail. There should also be major improvements and expansion of RTA service throughout the Cape. Second, if there absolutely must be 2 lanes in each direction, then at least on each bridge there must be one separated bus-only lane. Using traffic cones or similar devices, this lane should be in the direction coming to or from the Cape, depending on where most of the traffic is going

TABLE OF PUBLIC COMMENTS FOLLOWING DRAFT MRER/EA PUBLICATION

Comment #	Affiliation	Add to Mailing List (Yes/No)	Comment Date	Comment Type	Comment Subject																												Specific Comments/Questions
					ALTERNATIVES							ENVIRONMENTAL CONCERNS									TRANSPORTATION					OTHER							
					Favor Replacement	Third Bridge	Tunnel	Fill Canal	MassDOT Alternatives	USACE Alternatives	Design Recommendations	Water Quality	T&E Species	Fisheries	Flood Zones/Flooding	Climate Change	Historical/Cultural Concerns	Recreation	Noise/Air Quality	Socioeconomics	Traffic Concerns	Transportation Technology	Tolls	Weight Restrictions/ Concerns	Marine Transportation Considerations	Evacuation Concerns	Safety Concerns	EIS / NEPA Process	Public Involvement/ Communication Concerns	Impacts to Private Property	Timeline of Project	Other	
327		Yes	11/15/2019	Website	X																X						X	X					It's obvious that both of these highway bridges are outdated and no longer designed for the traffic demands of today and the future. Each time I pass over either of these bridges, I hesitate to use the left lanes due to oncoming traffic in the opposite lanes with no barrier protection in between. For safety reasons alone, I think that it's prudent to replace these bridges while taking all plans into careful consideration and study for the replacement bridges.
328		Yes	11/15/2019	Website					X							X						X											As we face runaway climate change, it makes no sense to replace and expand the Bourne and Sagamore Bridges. This would encourage increased auto travel when we need desperately to be moving in exactly the opposite direction. I urge you to expand public transit options instead.
329		Yes	11/15/2019	Website	X				X																								I favor the project. The impact on existing Cape traffic must be blunted by design of connecting roads.
330	MassBike	Yes	11/15/2019	Website					X	X	X							X				X					X						Thank you for the opportunity to comment on the Cape Cod Canal Highway Bridges MRE Study. We are hopeful that the redesign of these bridges will facilitate a safe and attractive bicycling connection between the South Coast and Cape Cod in-keeping with the goals of promoting sustainable transportation and recreation in the region. These two bridges are crucial connections for millions of residents and visitors, and they are the *only* way for people on bikes and on foot to cross the canal, so we appreciate how non-motorized transport is being taken into consideration at the start of the planning process. However, we feel the initial design of 10' width of the pathway is insufficient to meet the demands of folks who are walking and bicycling across the canal. MassBike urges the Army Corps to design the separated pathway to MassDOT modern standards. An example for reference on another major highway project with accompanying bike and pedestrian path is the Whittier Bridge in Amesbury, MA where the pathway was built at 15' wide with an additional 5' for overlooks and benches along the route. Crossing the bridges should be a pleasant experience to encourage non-motorized users to cross the canal. Since the length and distance of these bridges is quite long, spaces for benches are crucial for people who may not be able to walk or bike the whole bridge and need to rest. This is especially important for seniors and those of varying abilities. We also urge the Army Corps to incorporate seamless, safe, and separated connections on either side of the bridge to the Cape Cod Canal pathway system. The Cape Cod Canal Rail Trail is one of the most used regional pathways for both recreational users as well as utilitarian users, especially important access to fishermen along the canal. Current connections to/from these bridges from the pathway are unsafe and inconsistent, and this project affords us the opportunity to build the necessary connections to complete the pathway network on both sides of the canal. MassBike is encouraged to see so many partners working together on this project, including the Army Corps of Engineers, MassDOT, the Cape Cod Commission, local municipalities and local advocates. As the process moves forward into the design phase, we ask that MassBike be part of the stakeholders in whatever formal process takes shape -- working groups, task force, etc.

TABLE OF PUBLIC COMMENTS FOLLOWING DRAFT MRER/EA PUBLICATION

Comment #	Affiliation	Add to Mailing List (Yes/No)	Comment Date	Comment Type	Comment Subject																														Specific Comments/Questions
					ALTERNATIVES							ENVIRONMENTAL CONCERNS										TRANSPORTATION					OTHER								
					Favor Replacement	Third Bridge	Tunnel	Fill Canal	MassDOT Alternatives	USACE Alternatives	Design Recommendations	Water Quality	T&E Species	Fisheries	Flood Zones/Flooding	Climate Change	Historical/Cultural Concerns	Recreation	Noise/Air Quality	Socioeconomics	Traffic Concerns	Transportation Technology	Tolls	Weight Restrictions/ Concerns	Marine Transportation Considerations	Evacuation Concerns	Safety Concerns	EIS / NEPA Process	Public Involvement/ Communication Concerns	Impacts to Private Property	Timeline of Project	Other	
331		Yes	11/15/2019	Website					X	X					X	X		X			X	X		X									As a resident of Cambridge, MA who wants the best for both Cape Cod and the environment, I urge you to choose a plan that addresses traffic and gridlock by getting more cars off the road, rather than by increasing capacity for cars. The future of a low-lying, environmentally sensitive coastal region like Cape Cod depends on minimizing climate change and sea level rise. Increasing automobile access might help in the short term by eliminating traffic jams, but it will also spur development that will again lead to traffic and gridlock. On the other hand, increasing access by train, bus, and boat will encourage people to use transportation that\'s better for the environment. I\'m pleased to see that bicycle and pedestrian access is being discussed, but I urge you to go much further than that.
332		Yes	11/15/2019	Website						X	X									X	X						X						I am opposed to the significant expansion of the two bridges over Cape Cod Canal. Clearly, significant traffic problems have persisted for many years. Personally, I have dealt with it many times in my many years visiting the Cape for weekends and weeklong vacations. I try to travel at off-peak times to avoid traffic. I LOVE Cape Cod. I love the outer cape and the beaches. Every summer, I say thank you! to President Kennedy for saving this gorgeous National Seashore from development. Florida has beautiful beaches, but look across the street and you see high rise hotels. In Wellfleet, you look behind you and see dunes. Other non-protected parts of the Cape have not fared as well. Towns are no longer "Cape\" towns. They are suburbs with bigger and bigger homes. People come to the Cape for "Cape Cod" and make it into the homes and yards they just left. I would like to see the Cape preserved as much as possible. Bigger bridges and an easier commute will bring significantly more traffic and congestion on the Cape itself. More housing, more hotels, more restaurants, and more traffic on Cape roads. By all means make the bridges safe. But PLEASE do not create two super highways that will assuredly speed the deterioration of the beauty and remaining quiet of our precious Cape Cod.

TABLE OF PUBLIC COMMENTS FOLLOWING DRAFT MRER/EA PUBLICATION

Comment #	Affiliation	Add to Mailing List (Yes/No)	Comment Date	Comment Type	Comment Subject																												Specific Comments/Questions
					ALTERNATIVES							ENVIRONMENTAL CONCERNS									TRANSPORTATION					OTHER							
					Favor Replacement	Third Bridge	Tunnel	Fill Canal	MassDOT Alternatives	USACE Alternatives	Design Recommendations	Water Quality	T&E Species	Fisheries	Flood Zones/Flooding	Climate Change	Historical/Cultural Concerns	Recreation	Noise/Air Quality	Socioeconomics	Traffic Concerns	Transportation Technology	Tolls	Weight Restrictions/ Concerns	Marine Transportation Considerations	Evacuation Concerns	Safety Concerns	EIS / NEPA Process	Public Involvement/ Communication Concerns	Impacts to Private Property	Timeline of Project	Other	
333	Sandwich Bikeways & Pedestrian Committee	Yes	11/15/2019	Website					X		X							X				X					X						Like our friends, the Friends of the Bourne Rail Trail, we wholeheartedly endorse the draft plan to include designated bicycle and pedestrian pathways that are separated from traffic by physical barriers on the proposed Bourne and Sagamore bridge replacements. We think the recently completed Whittier Bridge on I-95 in Amesbury/Newburyport provides the perfect model for the replacement of the Cape Cod Canal bridges. We also think such a project provides carries an imperative to directly connect bridge pathways to the Cape Cod Canal service road paths on both sides of the canal. It would be a shame if we didn\'t completely connect the non-automotive network of paths. One of the goals of the bridge replacement project should be to provide safe and direct passage for cross-canal walkers, runners, and cyclists to the canal service road paths and the multi-use networks that will eventually connect to those paths and extend beyond the canal. Ultimately Cape Cod cycling committees and advocates are pursuing Vision 88 -- a connected, off-road and multi-use path network from Woods Hole to Provincetown. The Cape Cod Canal bridges should be an extension of that network -- especially for users of the planned Bourne Rail Trail and Cape Cod Rail Trail extension through Sandwich -- to points beyond Cape Cod. Imagine a cyclist trying to reach Woods Hole or Provincetown from the South Coast Bikeway or the Claire Saltonstall Bikeway, only to have to dismount and walk their bike across Sandwich Road and the railroad tracks to reach the canal from the Sagamore Bridge. Without a direct connection to the canal service road path, we would have defeated the purpose of providing cyclists a safe, direct and separated means of crossing the canal. As we move from planning into the design phase, we would appreciate being included as a stakeholder in whatever formal process takes shape (working groups, task forces, etc.).
334	Blue Institute At Cape Cod Bay	Yes	11/16/2019	Website					X	X	X					X						X										X	Just a short note to express my concern that 1) the Cape does not have the water and wastewater infrastructure currently to support all the additional cars that will be coming over these new bridges, 2) why is the State considering funding bridges without consideration of public transit opportunities such as a rail line coming over one of the new bridges - especially given the clear connection between carbon emissions and climate change impacts. Thank you for reading this - it's a unique opportunity for the Baker Administration to invest in the green & blue future of Cape Cod by investing in public transport.
335		Yes	11/16/2019	Website					X	X	X										X	X			X								I have been traveling to Cape Cod over the Sagamore bridge for 50 years. My family took me as a child (from Maryland) and now I go with my husband and child (from the Boston area) to visit family living on the Outer Cape. We believe that the proposed expansion of the bridge is much too large and will put too many cars onto the Cape\'s already crowded roads. Please consider alternatives to bridge traffic, including a CAR FERRY TO PROVINCETOWN and EXPANDED RAILROAD service. Many parts of the Cape are very walkable from the rail corridors. We oppose increasing vehicle volume over the Cape Cod canal near the Sagamore and Bourne Bridges.
336		Yes	11/16/2019	Website							X																X					X	I would like to request that, when the bridges are renovated, they are done so in a way that prevents drivers and their passengers in cars going over the bridge from seeing the water below. You see, my mother is terrified of heights, and is therefore terrified to drive over the bridges. I think that, if she couldn\'t see over the edges, down to the water below, this would help her tremendously. I understand that it might be harder with pick-up trucks and SUV's, but my mother typically drives a sedan. I think that, if there was a solid barrier, i.e. guardrail, on each side of the bridge, that was at least waist height, that prevented motorists from seeing the water, or at least limited what they could see, my mother's trepidation would be alleviated.

TABLE OF PUBLIC COMMENTS FOLLOWING DRAFT MRER/EA PUBLICATION

Comment #	Affiliation	Add to Mailing List (Yes/No)	Comment Date	Comment Type	Comment Subject																												Specific Comments/Questions
					ALTERNATIVES							ENVIRONMENTAL CONCERNS									TRANSPORTATION					OTHER							
					Favor Replacement	Third Bridge	Tunnel	Fill Canal	MassDOT Alternatives	USACE Alternatives	Design Recommendations	Water Quality	T&E Species	Fisheries	Flood Zones/Flooding	Climate Change	Historical/Cultural Concerns	Recreation	Noise/Air Quality	Socioeconomics	Traffic Concerns	Transportation Technology	Tolls	Weight Restrictions/ Concerns	Marine Transportation Considerations	Evacuation Concerns	Safety Concerns	EIS / NEPA Process	Public Involvement/ Communication Concerns	Impacts to Private Property	Timeline of Project	Other	
337		Yes	11/16/2019	Website	X																X											X	New bridges across Cape Cod Canal are urgently needed because of aging and safety. But appropriating funding for new bridges should be tied to a comprehensive plan to reducing both car trips both (1) to and from Cape Cod, and (2) on Cape Cod. Please make this a comprehensive review and plan for residents and visitors.
338		Yes	11/15/2019	Email							X										X							X					Finds no discernible scientific or engineering reasoning contained in the Draft EA that supports the final conclusion that is proposed in the FONSI that states the project is not a major federal action significantly affecting the quality of the human environment. MassDOT estimated in their study that traffic would increase on the Cape by 25% based on the type of bridge that will be replacing the current bridges. Current public infrastructure for transportation, water and wastewater, is already beyond peak design. Any sort of increase in population would certainly have an effect on the human environment. I reccommend that the USACE decide to proceed with a detailed statement (i.e., EIS) containing the information needed to make a fully informed decision that will consider all aspects and effects of the proposed actions, as required by the regulations issued by the President's Council on Environmental Quality (CEQ) at 40 CFR 1500-1508.
339		Yes	11/12/2019	Written					X	X	X										X	X					X						There is enough motor vehicle traffic on the Cape already. The infrastructure to safely handle existing traffic is not there. Keep the Cape rural, invest in public transportation, bike lanes, walkways. Invest in a sustainalbe future, commuter rail, public transportation, bikelanes on all state roadways.
340		Yes	11/12/2019	Written					X	X	X										X	X					X						Replacement plans should include state-of-the art facilities for pedestrians and cyclists on the bridges as well as substantially improved access to the bridges for both pedestrians and cyclists. Plans should incluse safe, convenient pedestriand and bycicle infrastructure that directly links the new bridges to the Cape Cod Canal Recreation Path on both sides of the canal. USACE should work with the USDOT to ensure there are safe, legal, public pedestrian railroad crossings to provide access to the south-side Canal Recreation Path at the southern end of both bridges.
341		Yes	11/9/2019	Written					X	X	X					X		X			X	X											Highlighted excerpts from Eve Zuckoff's excellent 30 Oct 2019 article as well as the chart of transit funding priorities from the Cape Cod Commission 2020 Regional Transportation Plan are attached. I oppose the Army Corps of Engineers plan to build two 6 lane bridges to replace the current Bourne and Sagamore Bridges at this time.
342	Cape Cod Commission	Yes	11/15/2019	Email												X				X		X			X		X		X				Commission looks forward to working closely with USACE to develop and design plans. Commission requests they get added to the appendix as a coordinating agency. Cominission staff encourage a continued focus on the relationship of this project with key regional issues identified in recently adopted regional plans including the Regional Policy Plan, Regional Transportation Plan, and Comprehensive Economic Development Strategy. Commission staff encourage an expanded discussion on the potential for expanded public transportation options with specific recommendations on additional investments to support bus, rail, and ferry transportation options. Effectively utilizing all available modes of transportation presents the best long-term solution for the region. Commission looks forward to providing feedback as more recommendations come in.
343	President, Massachusetts Building Trades Council	Yes	11/14/2019	Written																X					X							X	Assuming the plan is to replace both bridges, the estimated costs approach $1 Billion. In addition to the monetary costs, this bridge will have a significant impact on traffic, marine transportation, the local workforce and the regional economy. To minimize the above-mentioned impacts, I recommend that the USACE explore and implement the use of a Project Labor Agreement (PLA). (rest of letter for more details)

TABLE OF PUBLIC COMMENTS FOLLOWING DRAFT MRER/EA PUBLICATION

					Comment Subject																												
					ALTERNATIVES							ENVIRONMENTAL CONCERNS									TRANSPORTATION					OTHER							
Comment #	**Affiliation**	**Add to Mailing List (Yes/No)**	**Comment Date**	**Comment Type**	**Favor Replacement**	**Third Bridge**	**Tunnel**	**Fill Canal**	**MassDOT Alternatives**	**USACE Alternatives**	**Design Recommendations**	**Water Quality**	**T&E Species**	**Fisheries**	**Flood Zones/Flooding**	**Climate Change**	**Historical/Cultural Concerns**	**Recreation**	**Noise/Air Quality**	**Socioeconomics**	**Traffic Concerns**	**Transportation Technology**	**Tolls**	**Weight Restrictions/ Concerns**	**Marine Transportation Considerations**	**Evacuation Concerns**	**Safety Concerns**	**EIS / NEPA Process**	**Public Involvement/ Communication Concerns**	**Impacts to Private Property**	**Timeline of Project**	**Other**	**Specific Comments/Questions**
344	Senior Legal Counsel, Algonquin Gas Transmission, LLC (Subsidiary of Enbridge, Inc.)	No	10/30/2019	Written																										X			Algonquin is concerned that there is no mention of signficant Algonquin gas transmission facilities along the approach to th mainland side of the Bourne Bridge included in the MRER/EA. These include two (2) eight-inch diameter natural gas pipes each running for a distance of approximately 2,000 feet, and the Bourne Metering and Regulating ("M/R") Station in very close proximity to the Bourne Bridge. Algonquin believes that it's facilities located in these areas would be impacted in furtherance of the MRER/EA bridge replacement alternative and must be considered by the USACE in its analysis. Algonquin acknowledges that USACE has stated that it is deferring certain work to Phase II of the bridge replacement alternative design, including detailed survey of all utilities impacted by the recommended alternative and associated cost estimates for gas transmission/utility relocation. Nonetheless, the omission and corresponding silence at this phase is a concern for Algonquin. While the MRER/EA notes that there is an Algonquin gas line near the Sagamore Bridge, there are additional Algonquin gas transmission facilities in close proximity to the mainland side of the Sagamore Bridge. Algonquin's facilities include not one, but two separate pipes - an eight-inch diameter pipe running appriximately 400 feet and the second is a larger 18-inch diameter pipe running approximately 1,500 feet - and the Sagamore M/R Station. These are significant gas transmission facilities. Similar to the omission of the gas transmssion facilities in proximity to the Bourne Bridge, the ommission of these facilities adjacent to the Sagamore Bridge at this phase is a concern for Algonquin. The USACE must consider the ommitted Algonquin facilities for a complete analysis of the potential impacts of the recommended alternative. Likewise, deferring a more robust relocation impacts analysis does not seem appropriate given the location of Algonquin's facilities in such close proximity to the bridges. Any potential relocation of these facilities will be time intensive projects with long lead times for land acquisition, permitting, design and/or construction and extensive planning to ensure continuity of service to Algonguin's customers. In addition, the relocation of transmission facilities in the area of the USACE's project has the ptoential to impact and require work on portions of Algonquin's facilities outside and/or upstream of the Bridge Study Areas. (see written letter for contact information and to schedule meeting times)

TABLE OF PUBLIC COMMENTS FOLLOWING DRAFT MRER/EA PUBLICATION

Comment #	Affiliation	Add to Mailing List (Yes/No)	Comment Date	Comment Type	Comment Subject																												Specific Comments/Questions
					ALTERNATIVES							ENVIRONMENTAL CONCERNS									TRANSPORTATION					OTHER							
					Favor Replacement	Third Bridge	Tunnel	Fill Canal	MassDOT Alternatives	USACE Alternatives	Design Recommendations	Water Quality	T&E Species	Fisheries	Flood Zones/Flooding	Climate Change	Historical/Cultural Concerns	Recreation	Noise/Air Quality	Socioeconomics	Traffic Concerns	Transportation Technology	Tolls	Weight Restrictions/ Concerns	Marine Transportation Considerations	Evacuation Concerns	Safety Concerns	EIS / NEPA Process	Public Involvement/ Communication Concerns	Impacts to Private Property	Timeline of Project	Other	
345		Yes	10/10/2019	Written					X											X									X	X			Turtle Rock, LLC and the Bilzekian Family own and operate the Christmas Tree Shops business as well as commercial and residential properties abutting the Sagamore Bridge and Exit 1 of Route 6 westbound, including two retail buildings, three vacant lots and two residential units with six apartments with abutting properties having been recently acquired with plans for additional development (see written letter with enclosed map). The property and business are a valuable asset to the family as well as the community (see written letter detailing jobs, payroll, taxes and other economic benefits that the business provides to the local economy). The recommendation by the USACE to replace the Sagamore Bridge is alarming and the process has happened with no notice to abutters. None of the information that has been given to the Chambers of Commerce in the area has been shared with the abutters or businesses that will be affected by the bridge changes and the possibility of MassDOT closing Exit 1 westbound off Route 6. Only second-hand new and past reports of meetings have been our source of late information. Recent changes on Adams Street to one-way and the loss of one curb cut without notification by MassDOT or discussion with abutting property owners has created safety hazards, additional traffic, and confusion on our property. The business and community at the east end of the Sagamore Bridge need to be part of the discussion and process of resolution as we provide jobs and taxes to the immediate area. In the event that a new bridge is needed, we want to work with the USACE to make sure that the business in the area is preserved. We are going to commission our traffic study to demonstrate the impact of removing Exit 1C and the impacts on the business. We reserve the right to submit this submit.We are asking for your help to preserve and improve traffic in this area so that it will grow and provide for the future of Cape Cod, Boure, the tourism dollars that Christmas Tree Shops has brought in the past and expects to bring in the future, and most importantly, the employees that rely on the jobs this area provides. We believe closing the the current exit will negatively impact our location and not improve the traffic flow off Cape Cod.
TOTAL					**112**	**6**	**12**	**6**	**102**	**71**	**133**	**2**	**3**	**3**	**6**	**36**	**16**	**13**	**12**	**17**	**127**	**89**	**16**	**3**	**11**	**5**	**48**	**8**	**27**	**32**	**10**	**66**	

Cape Cod Canal Highway Bridges Draft Major Rehabilitation Evaluation Report (MRER) and Environmental Assessment (EA)
Public Comment Summary Report

Pre-Draft MRER Comment Summary

The United States Army Corps of Engineers (USACE) held public information meetings in December 2018 prior to issuance of the Cape Cod Canal Highway Bridges Draft MRER and EA. The public information meetings were conducted to inform the public why the USACE was completing the MRER study. The USACE accepted comments via public meetings, the project website[1], electronic mail (e-mail)[2], and regular mail for consideration in the development of the Draft MRER and EA. The following is a summary of the public comments (103 total comments) received between 4 December 2018 and 2 October 2019 prior to publication of the Draft MRER/EA on 3 October 2019. The comments received during this time period are also included in the attached comment summary matrix which is organized to group comments received prior to publication of the Draft MRER/EA versus comments received after publication of the Draft MRER/EA during the public comment period.

Traffic Concerns

The majority of comments received prior to the issuance of the Draft MRER/EA were related to traffic concerns. Fifty-two (52) public comments were received noting a need to correct the traffic congestion regularly occurring on the Cape Cod Canal highway bridges (the “Bridges), nearby roadways, and roadways throughout Cape Cod, especially during the peak summer tourist season. Residents spoke of a need to relieve the already congested side streets due to traffic increases on main roads, and they wished the new bridges would not add to the problem of residential streets being impassable. Residents also expressed their concerns with emergency response times being delayed due to the bridge congestion. They said with the town of Bourne being split by the Canal, there are no emergency response vehicles for the town of Bourne on the Cape Cod side of the town. Residents of Bourne worry about the potential delayed response times on the bridges or in the area of the Bourne rotary. Other concerns came from commuters that stated their commute time is already long enough and any additional traffic would make it unbearable. In addition to the increased volumes of traffic crossing the Bridges both during the summer tourist season and regular year-round daily commuters since initial construction, commenters identified the age and design of the Bridges (including narrow lane widths, lack of breakdown lanes, and frequent maintenance work on the Bridges), as well as the design of the Canal area approach roadways as primary contributing factors to traffic congestion. Some commenters expressed concerns over any proposed alternative to build bridges with more lanes, stating that would result in increased volumes of travelers to Cape Cod and subsequent traffic, and displace traffic congestion from the major highway routes to surrounding local secondary roads that were noted to be already at capacity. Other commenters expressed concerns that any further increase in traffic would be detrimental to Cape Cod’s economy and could result in a decrease of the area’s property values. These commenters stated that they felt any further increase in traffic could have an adverse effect on property values, as it could potentially drive people away from buying homes on Cape Cod to avoid having to deal with the traffic congestion. Other concerns were similar in the sense that they were concerned that traffic congestion would make tourists decide to not vacation on Cape Cod, which would negatively impact the economy of Cape Cod.

---

[1] www.capecodcanalbridgesstudy.com

[2] nae-pn-nav@usace.army.mil and CapeCodBridgesStudy@usace.army.mil

Response: Please see Section 6.6.7 of the EA for a detailed discussion on traffic modeling studies. The study area of the traffic analysis is comprised of the Bourne and Sagamore Bridges and seven major connecting routes.

Favor Replacement
Twenty-eight (28) comments were received in support of replacing the Bridges, and these same comments overwhelmingly expressed concern that the current Bridges are unsafe for use. Commenters stated there is a need for wider travel lanes and a safe bicycle/pedestrian lane. It was noted that the bridges have exceeded their life expectancy and replacement is imperative to maintain the economic environment of Cape Cod. Commenters also stated that continued repairs to the Bridges have become more frequent, are a poor use of public funds and contribute to the ongoing traffic concerns.

Response: The EA discusses replacement of the bridges in Section 5.0.3. Under this alternative, new bridges would be constructed next to existing bridges and to modern standards. The bridge decks would be widened to include two through lanes and one auxiliary lane each way.

Safety Concerns
Twenty-four (24) comment submissions related to safety concerns with the condition of the current Bridges. The majority of the individuals believe the two existing Bridges are unsafe and pose a safety issue for motorists from motor vehicle accidents due to the narrow travel lanes, the high speeds traveled by commuters, and the lack of medians between the on and off-going traffic. Commenters also requested safer access for bicycles and pedestrians, with some suggesting elevated sidewalks and bike paths. Concerns also identified that the Town of Bourne's emergency response services are stationed on the mainland side of the Canal and dispatch to locations on the Cape side of the Canal, requiring use of the Bridges and response times are affected by traffic congestion associated with the Bridges and approach roadways. Individuals expressed potential evacuation concerns for Cape Cod, as the Bridges would be a bottleneck site for traffic trying to leave Cape Cod in the event of an emergency. One commenter noted that hazardous materials are transported over the bridges, and others provided suggestions to enhance safety on the current Bridges prior to replacement, such as incorporating rumble strips and reflectors into roadway surface of the Bridges.

Response: Public health and safety concerns are discussed in Section 6.6.6 of the EA. When the replacement bridges' construction is completed there will be a positive impact on health and public safety.

USACE Alternatives
Twenty (24) comments were directed towards potential alternatives that the USACE identified and presented at the public information meetings or additional alternatives that should be explored within the MRER and multiple commenters expressed their disappointment that too few alternatives were analyzed. Comments included recommendations that the USACE evaluate alternatives beyond bridge rehabilitation and replacement, and explore the latest innovations in transportation technology when considering potential alternatives. Some commenters suggested that the USACE examine the construction of multiple low causeway bridges across the Canal rather than construction of two large bridges, while others suggested that two new bridges be constructed beside the existing bridges such that one bridge could be used for traffic coming onto Cape Cod while the other is used for traffic headed off Cape Cod. One comment mentioned building one much larger bridge with numerous travel lanes to facilitate the transport of more traffic, another mentioned reversing the travel direction in one (1) lane on the Bridges using

flexible traffic lanes to open an additional lane during peak travel times as is done on the Southeast Expressway near Boston, and others questioned if the railroad bridge could be modified to allow automobile travel as well as rail transport. One commenter suggested that multiple tunnels be excavated under the canal, and some suggested that marine vessel traffic within the Canal is minimal and the Canal should be filled in or partially filled in to allow for a less expensive causeway style crossings for motor vehicles. Multiple individuals suggested that the USACE incorporate rail transport into the design, and two people mentioned diverting freight truck traffic to the port of New Bedford, MA for shipping of freight to Cape Cod and the Islands via expanded marine ferry systems. Multiple commenters also mentioned exploring the use of Joint Base Cape Cod as an option to expand roadways into in order to bypass the Bourne rotary and reduce traffic congestion.

Response: USACE alternatives are discussed in Section 5.0 of the EA. CEQ regulations require federal agencies to consider a reasonable range of alternatives that meet the purpose and need of a proposed action in their NEPA review. Reasonable alternatives include those that are practical or feasible from a technical and economic standpoint.

MassDOT Alternatives

Twenty (23) public comments were directed towards alternatives to surrounding approach roadways or other regional roadway infrastructure that the Massachusetts Department of Transportation (MassDOT) is either responsible for or should explore. Some suggestions were to remove the rotary at the southern approach to the Bourne Bridge and add additional travel lanes on Route 28, widening the associated lanes and roadways, and to relocate Exit 1C on Route 6 further away from the Sagamore Bridge to allow for better blending of westbound traffic coming on to Route 6 prior to crossing the bridge. Commenters also suggested reducing speed limits on nearby roads that approach the bridges, as well as on the bridges, and prohibiting drivers from changing lanes while traveling over the bridges. Most comments related to this topic stated that the majority of traffic concerns originate from local roadways surrounding the Bridges and MassDOT needs to focus on alleviating traffic congestion in those locations.

Response: The EA discusses the MassDOT alternatives under Section 7.2 of the EA, Cumulative Impacts. The MA Department of Transportation (MassDOT) completed a Cape Cod Canal Transportation Study in May 2019. The purpose of this regional “conceptual planning study” was to “evaluate existing and future transportation safety and congestion deficiencies in the Cape Cod Canal Study Area” and included the development and analysis of multimodal transportation alternatives

Public Involvement/Communication Concerns

Twenty-two (22) comments addressed the need for greater public involvement and increased or better communication during the process of designing and planning for the future of the Bridges. Most comments on this topic addressed the need for the USACE to actively engage the Town of Bourne, MA and actively work with town officials throughout the planning and design process since they felt this community would experience the greatest impact from any proposed alternatives related to rehabilitation or replacement of the Bridges. Other individuals stressed the need to keep local stakeholders involved (such as the Town of Bourne Board of Selectmen, Cape Cod Commission, Verizon), as some felt they were not adequately informed of the USACE’s plan to hold public meetings, with one local abutting business owner stating that a recent road project on the Sagamore Bridge and approach roadways occurred without any notifications to the direct abutters and the work resulted in a direct disruption to his business. One commenter mentioned that the USACE should consider the use of social media to advertise planned public meetings/events such that notice of meetings can be better circulated and allow for increased notice and attendance of concerned individuals with comments, questions and concerns. Multiple commenters expressed a desire for the USACE to conduct public meetings in a question-and-answer format so that concerns could be addressed at the meetings. A number of commenters suggested there is a disconnect between MassDOT and the USACE and recommended they collaborate for this monumental project. One comment from a utility company identified that it is critical that the USACE consult with local utility companies through the entire project as both Bridges are corridors for utility infrastructure which needs to remain operational throughout any planned construction work.

Response: Public involvement and communication concerns are discussed in Section 8.0 and Appendix F of the EA. USACE regulations (the Planning Guidance Notebook – ER 1105-1-100) and the National Environmental Policy Act (NEPA) require that all efforts be made to involve the public in preparing and implementing NEPA procedures and to hold public meetings whenever appropriate (USACE NEPA Implementing Procedures 33 CFR Part 230, CEQ 40 CFR 1500-1508).

Third Bridge

Eighteen (18) comments were submitted suggested that construction of a third bridge would help alleviate traffic volumes on the Bourne and Sagamore Bridges, resulting in less traffic congestion. Individuals commented that a third bridge crossing would assist in dispersing traffic, reduce wear and tear on the Bourne and Sagamore Bridges, could allow officials to implement weight load restrictions and designate bridges for freight traffic, and assist with evacuation needs during an emergency situation. Some comments suggesting implementation of a tolling system to recover costs associated with construction and/or maintenance a third bridge, and others suggested renovating the existing railroad bridge to create a third means of motor vehicle access to and from Cape Cod. A few commenters were disappointed that the concept of a third bridge was not explored more thoroughly and expressed the belief that MassDOT is against the installation of third crossing, and as a result, it has not been considered as viable solution by the both the USACE and MassDOT.

Response: Section 5.1.2 of the EA discusses the alternative of a third bridge. MassDOT initially studied the concept of a mid-canal crossing, but determined there were significant resource impact issues and this alternative was not carried forward in the MassDOT *Cape Cod Canal Transportation Study* (2019).

Socioeconomics

Fifteen (15) comments were received pertaining to the socioeconomic effects on individuals and businesses resulting from traffic congestion on the existing Bridges, as well as the potential effects of the proposed alternatives considered within the MRER. Individuals noted concerns about traffic issues during construction that may impact Cape Cod and the region's economy, concerns with the possibility of businesses and residences having to be acquired/condemned through the eminent domain process, as well as how property values surrounding the project will be affected. One commenter stated that the environmental assessment should be used as a foundation for both the biological and the socioeconomic impacts of the area. Others stated that if weight restrictions are imposed on the existing Bridges, an economic impact analysis should be competed to determine what affect that may have on Cape Cod commerce. Individuals also requested the USACE evaluate the potential economic impact of closing the Canal to marine vessel traffic.

Response: Socioeconomic effects are evaluated under Section 6.6 of the EA. Construction of the replacement bridges is not expected to have a significant impact on population size or demographic makeup.

Timeline of Project

Fourteen (14) comments specific to the timeline of the project were received requesting a more specific timeline for completion of the MRER study or requests to expedite either the MRER process or the process of correcting traffic problems on Cape Cod. One comment stated that the 50-year project lifecycle timeframe considered for the MRER study is not an appropriate or efficient duration given the USACE anticipates the major rehabilitations will require a seven-year construction period per bridge and that this 14-year timeframe doesn't include annual maintenance construction duration, and all of this time should be factored into the study duration.

Response: The project timeline will be developed during Phase II of the study.

Recreation

Fourteen (14) comments were submitted regarding recreation activities on Cape Cod and the Canal region. The majority of the comments regarding recreation requested the USACE incorporate safe planning for bicycle and pedestrian lanes into any planned rehabilitation or replacement of the Bridges to accommodate travel over the bridges with direct connections to existing sidewalks and/or bicycle trails on both sides of the Canal. The Cape Cod Canal Sportsman Club is located adjacent to the Bourne Bridge and members have identified concerns with how the club would be affected by any plans to either rehabilitate or replace the Bridges. Other commenters mention how traffic congestion restricts the recreation potential for the Canal region, and that the Canal is major attraction for many tourists and residents, therefore its recreational value should be considered significant when evaluating impacts for project.

Response: The EA discusses recreation under Section 6.6.4 in the EA. Construction of the bridges will however require the closure of the canal for 30 days each which will disrupt fishing and boating activities. In addition, there may be other temporary impacts such as portions of the access road will be closed for public use during construction which is projected to last for five years for each bridge.

Marine Transportation/Consideration

Nine (9) comments received were related to marine transportation through the Canal. The majority of these comments expressed belief that currently there is no significant commercial shipping occurring through the Canal and the vast majority of boating activity within the Canal is from recreational pleasure crafts. As a result, individuals feel low clearance bridges or causeway style crossing should be an option when considering replacement of the existing Bridges. Commenters also questioned how replacement bridges will affect commercial vessels and whether the aerial clearances will be the same or larger than the current Bridges.

Response: Marine transportation considerations are discussed in Section 6.6.4 of the EA. The USACE is responsible for operating and maintaining the Cape Cod Canal. The primary mission of the Canal is to provide safe navigation to the commercial and recreational vessels that transit the 17.5 mile waterway each year.

Other

Nine (9) comments were submitted in regard to miscellaneous remarks which included concerns with the cost of the bridges, the public's opinion on the appropriate capacity of the bridges, queries on whether local labor unions will be utilized for construction of any proposed alternatives, and a solicitation for video production assistance via unmanned aerial vehicles (UAVs) prior to or during construction of the bridges. Other comments included requests to relocate any natural gas pipelines on the bridges underground for safety reasons and requests by individuals with bridge construction experience to be consulted during development of the project.

Response: Most of the "other" comments will be addressed in Phase II of the project.

Fill Canal
Nine (8) commenters expressed the belief that the Canal currently experiences infrequent use by large marine vessels and that construction of the Canal would not have been completed in the present day based on the overall limited extent of commercial maritime traffic. These individuals feel the USACE should evaluate filling the Canal and converting roadway crossings to lower clearance bridges or causeway style crossings and one individual suggested filling the area and creating a greenway.

Response: Section 5.1.5 of the EA discusses the alternative of filling the canal. The USACE has considered the potential impacts of filling in the canal and has determined this is not a practicable alternative due to the significance of these impacts.

Impacts to Private Property
Eight (8) individuals provided comments regarding potential impacts to private property, including concerns about how the bridge replacement projects will affect property values, questions about the process of eminent domain and how businesses located along the Canal will be affected by the project.

Response: Impacts to private property will be addressed during Phase II of the project.

Transportation Technology
Seven (7) comments were submitted regarding transportation technology. Some individuals suggested exploring non-traditional crossing concepts such that the final design may be allowed to accommodate future transportation technology. Commenters suggested the USACE consider forthcoming transportation technology such as automated car management systems to bring cars to and from the Bridges safely or the integration of a high-speed rail system for public mass transit to Cape Cod.

Response: Transportation technology will be addressed during Phase II of the project.

EIS/NEPA Process
Two different commenters submitted five (5) separate comments relating to the National Environmental Policy Act (NEPA) and/or the EA or Environmental Impact Statement (EIS) process (with one commenter submitting four of the comments). One commenter suggested that the USACE is not adequately considering the potential impacts to the human environment, which would require an EIS for the proposed alternative, as opposed to the more simplified EA being completed, and also stated that the EA should be used as a foundation for both biological and human environmental impacts, and the USACE should supply a link to their regulations for complying with NEPA on the project website. One commenter stated they believe that completing the NEPA process and issuance of a FONSI prior to the acquisition of funding for any proposed alternative seems to be backward to how the process should be completed.

Response: EIS/NEPA Process is addressed in Section 2.2 of the EA. NEPA requires Federal Agencies to assess the environmental effects of their proposed actions prior to making decisions. The USACE is preparing this Environmental Assessment (EA) pursuant to the White House Council on Environmental Quality (CEQ) Implementing Procedures for NEPA (40 CFR Parts 1500-1508) and USACE Procedures for Implementing NEPA (Engineering Regulation ER-200-2-2).

Evacuation Concerns
Four (4) comments were received regarding evacuation safety. Individuals noted that the USACE needs to consider evacuation routes and requirements when designing the new bridges and have a plan in place during construction to ensure the safety of Cape Cod's residents.

Response: Evacuation concerns are discussed in Section 6.6.6 of the EA. Emergency evacuation of Cape Cod is an important issue due to the high probability of a hazardous event occurring, and because of the high traffic volume and low capacity road conditions that are exacerbated by congestion created by the bridges. Bridge replacement with additional lanes will improve access on and off of Cape Cod during emergency evacuations.

Tunnel
Three (4) comments were received regarding the installation of tunnels as an alternative to the bridge replacement projects. Commenters believe installation of multiple tunnels would ultimately be more cost effective and require less annual maintenance than two elevated structures, and one individual requested a full study be performed on the installation of a tunnel before dismissing the concept as a viable option.

Response: The tunnel alternative is discussed in Section 5.1.3 of the EA. Tunnels are typically not cost effective when compared to bridge spans that are under a mile in length. Both the Sagamore and Bourne bridges are less than this distance.

Climate Change
Three (3) comments were submitted with respect to climate change. Individuals requested the USACE consider climate change, current and projected floodplain elevations, and increased incidences of extreme weather events during the bridge design process.

Response: The EA discusses climate change in Section 6.1.4. None of the alternatives would have direct or indirect impacts to the climate of the region. Only short duration, minor discharges of carbon-based pollutants would occur during construction activities that could contribute to greenhouse gases.

Historical/Cultural Concerns
Three (3) comments were submitted regarding historical/cultural concerns and all individuals suggested the USACE attempt to retain the visual aspects of the current bridge design when engineering the replacement structures, and that the plaques for the Bourne and Sagamore Bridges be preserved for historical value.

Response: EA Section 6.5 discusses historic and archaeological resources. The preferred alternative would have an adverse effect on the bridges and at least two identified archaeological sites, possible unidentified archaeological resources, and several historic districts. The effects would be indirect (visual and/or viewshed) as well as direct (possible archaeological sites). The tribes attended a meeting in March 2019 and concurred with the approach taken in Phase I of the study to evaluate continued repair and maintenance, major rehabilitation, or replacement of the bridges. A formal letter was also sent to the tribes on July 17, 2019. The SHPO concurred with this approach in a letter dated August 22, 2019 (Appendix E). Additional consultation with the SHPO and THPOs on the location of the bridges and the design will be required during Phase II of the project. A Memorandum of Agreement will be developed in consultation with the SHPO, THPOs, MBUAR, and local interested parties during this phase to develop a plan to avoid, minimize, or mitigate the effects of bridge replacement on historic properties. Consultation with the SHPO and tribes is ongoing.

Noise/Air Quality
Three (3) comments regarding noise/air quality were submitted and remarks included concerns about noise and air pollution to adjacent neighborhood during construction and suggestions to incorporate rail transport as a viable option to reduce the extent of local air pollution to the area.

Response: Noise is addressed in Section 6.6.10 of the EA. Air Quality is discussed in Section 6.1.6. Only minor impacts to noise/air quality are anticipated from the preferred alternative.

Tolls

Three (3) individuals provided comments regarding the use of tolls on any proposed replacement bridges. One individual inquired as to the likelihood of MassDOT installing a future tolling system. Others noted they were either in support or against the requirement of a tolling system on any proposed new structures.

Response: Tolls will be addressed during Phase II of the project.

Weight Restrictions/Concerns

Three (3) comments were submitted regarding weight restrictions/concerns on the existing Bridges. One individual stated that if weight restrictions are imposed on the new bridges, an economic impact analysis should be competed to determine what affect that may have on Cape Cod businesses. Other comments included requests to impose weight restrictions on the new bridges as they age, such that use by heavy vehicles does not exacerbate the deterioration of the structures.

Response: Weight restrictions will be addressed during Phase II of the project.

Draft MRER/EA Comment Summary

Following publication on 3 October 2019 of the Cape Cod Canal Highway Bridges Draft MRER and EA for public review and comment, the USACE held agency recommendation meetings in October 2019 during the ensuing 30-day public comment period following publication of the MRER/EA. The agency recommendation meetings were conducted to inform the public of the results of the Draft MRER/EA and the agency-recommended alternative for the Bourne and Sagamore Bridges. The agency recommendation meetings were also conducted to solicit comments and questions from the public, and allow the USACE to directly respond to any questions received at the meetings. Prior to the conclusion of the 30-day public comment period, the USACE elected to extend the comment period for another 15 days, concluding the comment period on 15 November 2019. The USACE accepted comments via the agency recommendation meetings, the project website[3], electronic mail (e-mail)[4], and regular mail for consideration in the development of the Final MRER and EA. The following is a summary of the public comments (345 total comments) received between 3 October 2019 and 15 November 2019 following publication of the Draft MRER/EA on 3 October 2019. The comments received during this time period are also included in the attached comment summary matrix which is organized to group comments received prior to publication of the Draft MRER/EA versus comments received after publication of the Draft MRER/EA during the public comment period.

Design Recommendations

One hundred and thirty-two (132) public comments provided specific design recommendations for the replacement bridges. Numerous comments were received suggesting design of a double-decker style bridge system with one deck designated for traffic heading onto Cape Cod and the other deck for traffic heading off Cape Cod as a way to minimize the overall footprint of the replacement bridges on adjacent residences and businesses. Comments also included recommendations to size the bridges and number of lanes (generally recommending six to eight in total) to account for future traffic needs, the incorporation of specific auxiliary lanes to facilitate on and off ramp activity without impacting the main traffic flows, the installation of a safe median between opposing travel vehicles and full-size breakdown lanes, the installation of flexible traffic lanes that could be adjusted to respond to traffic needs during peak travel times and the expansion of available lanes on Route 28, Route 3 and Route 6 at all approaches, extending 0.5-mile from the bridges to reduce bottleneck affects.

Numerous individuals also requested the new bridge systems incorporate bicycle and pedestrian lanes on both sides of each bridge. Commenters noted that the design should include bicycle/pedestrian lanes that are separated from traffic flows, with adequately sized travel areas and benches for overlooks, as well as interconnections that directly link the lanes to the Cape Cod Canal Bike Path on both sides of the Canal. A significant number of comments were also received regarding the need for the new bridges to incorporate public transportation systems, specifically requesting rail systems be included in the design and agencies consider designating specific travel lanes for high occupancy vehicles and buses to reduce single-car use on Cape Cod.

Conversely, some individuals noted bicycle use and pedestrian access should not be incorporated into the design of a new or rebuilt system, as they believe bridge use for recreational purposes is overall limited. Multiple comments also noted that if a rebuild or a replacement is necessary, the bridges should not be expanded beyond two lanes in each direction as the existing approach roadways and secondary roads on Cape Cod cannot accommodate more traffic. Individuals feel the USACE and MassDOT should investigate redesigning the rotaries and approaches to the Bridges to alleviate traffic congestion issues rather than expanding bridge systems to accommodate higher traffic volumes that cannot be supported by the area's existing roadways.

---

[3] www.capecodcanalbridgesstudy.com

[4] nae-pn-nav@usace.army.mil and CapeCodBridgesStudy@usace.army.mil

Multiple requests were received to preserve the current appearance of the Bridges when engineering a new design and if feasible to include solar photovoltaic panels to offset energy needs and lighting requirements of the bridges. Individuals noted anticipated sea-level rise should be factored into the siting of the new bridges and associated infrastructure, and an attempt should be made to create marine habitat at the base of the footings to offset impacts from the installation of supports within the Canal.

A comment from Vineyard Wind, an offshore wind renewable energy company, specifically requested the USACE consider evaluating the design of the replacement bridges such that they include the ability to accommodate electric transmission cables on or under the bridges. Vineyard Wind anticipates additional high voltage transmission lines will be needed to accommodate new power generation from various renewable energy sources offshore and on Cape Cod. They believe the new bridge installations could provide an opportunity to support the required electrical infrastructure at a lower cost and with less disruption if completed as part of the bridge replacement project.

Response: Design recommendations will be addressed during Phase II of the project.

Traffic Concerns

One hundred and twenty-seven (127) public comments were received in response to the Draft MRER/EA, identifying a need to resolve local traffic issues associated with the Bridges and approach roadways; however, multiple individuals expressed concerns with adding higher traffic capacity bridges, as they believe it will encourage additional visitors to the Cape Cod region and increase traffic flows onto local roadways and communities. Concerns were also identified with adding additional lanes along the bridges as residents feel the supporting incoming and outgoing routes cannot accommodate an increase in traffic. Individuals believe larger capacity bridges will result in continued traffic congestion as lanes along Route 3, Route 6 and Route 28 are limited in their ability to process traffic when traveling both on and off Cape Cod.

As an alternative or a supplement to the replacement bridges, individuals commented that the USACE and MassDOT should consider options to reduce traffic or disperse traffic volumes, such as the conversion of the existing railroad bridge to carry motor vehicle traffic, the addition of a tunnel beneath the Canal to provide roadway access to Cape Cod, the reconfiguration of Route 6 and Route 3 to reduce traffic backups, the use of land on Joint Base Cape Cod to facilitate travel between the two bridges, and the redesign and/or elimination of the rotaries to ease traffic congestion.

A significant number of comments were also received related to the need for mass transit on Cape Cod as well as the need for the expansion and improvement of the available public transportation networks in Southern New England. Individuals feel funding for the new bridges should be directly tied to a comprehensive plan to reduce single-car use on Cape Cod. Several commenters believe traffic congestion could be alleviated via the use of busses, trains and ferries from various communities on the South Coast and South Shore of Massachusetts, and that commercial freight traffic and services to Martha's Vineyard, Nantucket and other island communities should be rerouted to locations with existing ferry terminal facilities, such as New Bedford, MA.

Multiple individuals expressed concerns with the management of traffic during construction of the replacement bridges and issued specific comments pertaining to the negative effect the bridge construction work may have on local roads and businesses, as well as impacts on school busses and first responders. A number of comments were received requesting officials maintain access for cyclist and pedestrians during construction of the new crossings, as well as requests to consider ferry services from Plymouth, MA to reduce traffic on Route 3 during construction.

Response: Please see Section 6.6.7 of the EA for a detailed discussion on traffic modeling studies. The study area of the traffic analysis is comprised of the Bourne and Sagamore Bridges and seven major connecting routes.

Favor Replacement

One hundred and twelve (112) public comments have been received to date which are in favor of replacement of both the Bourne and Sagamore Bridges. The overwhelming majority of the comments received recognized the bridges are past their expected lifetimes, functionally obsolete, present safety hazards due to their current conditions and cited the replacement projects as an economic necessity and a means of ensuring safe and efficient travel to and from Cape Cod. Many individuals who favor replacement also noted specific safety, transportation and design recommendations, all of which have been detailed in each subject's corresponding section.

Response: The EA discusses replacement of the bridges in Section 5.0.3. Under this alternative, new bridges would be constructed next to existing bridges and to modern standards. The bridge decks would be widened to include two through lanes and one auxiliary lane each way.

MassDOT Alternatives

One hundred and one (101) public comments were received regarding potential MassDOT alternatives that could assist with alleviating traffic congestion around the Sagamore and Bourne Bridges. A significant number of participants recognize the bridges are in need of replacement and also serve as a primary source of the traffic congestion; however, most believe there will be no net improvement to traffic congestion unless the approaching highway systems and local roadways that support travel near the Bridges are modified to facilitate the flow of traffic. Multiple individuals requested the MassDOT work with the USACE to develop a comprehensive approach to improving traffic patterns in the Canal area and not focus solely on new high capacity bridge systems. Individuals commented on the need for the reconfiguration of the existing roadways near the Bridges to reduce traffic on local roadways caused by motorist attempting to utilize "short cuts" to bypass traffic backups, the need for a flyover system at the Bourne Bridge to allow traffic to continue south on Route 28 without intersecting local roadways, the potential use of land on Joint Base Cape Cod to reduce traffic flows along Sandwich Road and the Scenic Highway, and a study to determine if the rotaries can be removed entirely as they are inherently prone to traffic jams along Route 28. Individuals are requesting MassDOT consider expanding the number of lanes associated with Route 3, Route 6 and Route 28 along the Bridge approaches to allow traffic to merge onto the roadways well before reaching the bridges to help reduce potential bottleneck affects. Some individuals feel Route 6 is at capacity and the MassDOT needs to review expanding the roadway in its entirety and underpass systems should be incorporated into the design of both bridges to minimize impacts to local residents and business owners near the Bridge crossings.

Response: The EA discusses the MassDOT alternatives under Section 7.2 of the EA, Cumulative Impacts. The MA Department of Transportation (MassDOT) completed a Cape Cod Canal Transportation Study in May 2019. The purpose of this regional "conceptual planning study" was to "evaluate existing and future transportation safety and congestion deficiencies in the Cape Cod Canal Study Area" and included the development and analysis of multimodal transportation alternatives

Transportation Technology

Eighty-nine (89) comments were received requesting the USACE incorporate alternative transportation technology into the bridge replacement projects as well as the supporting roadway systems. Many individuals cited that the projects, as proposed, are in direct conflict with numerous goals of the Cape Cod 2020 Regional Transportation Plan, which prioritizes the development of pedestrian and cycling access and mass transit systems on Cape Cod. Commenters noted the objective of the project should be to facilitate the movement of more individuals, not more vehicles, and the USACE and MassDOT should be engineering the replacement projects to accommodate rail transport, designated pedestrian and bicycle crossing locations, designated high occupancy vehicle and bus lanes, as well as other available measures to discourage additional single-car motorist on Cape Cod. Affected residents believe the public transportation system on Cape Cod is currently inadequate and incorporating the infrastructure necessary to improve the regions mass transit system is critical and should be incorporated into the project design.

A few individuals noted that use of a ferry system from various locations along the South Coast and South Shore of MA during construction of the bridges should be utilized to lessen the volume of congestion, and new permanent passenger and freight ferry systems should be employed during peak travel periods throughout the year.

Response: Transportation technology will be addressed during Phase II of the project.

USACE Alternatives

Seventy (70) comments related to potential alternatives being considered by the USACE were submitted during the Draft MRER/EA comment period. Several individuals noted they were in favor of rehabilitating the existing bridges and expanding their overall size to accommodate four standard-width travel lanes. Some stated the USACE should contemplate converting the existing bridges into one-way crossings and constructing new bridges adjacent to the existing crossings, or retaining the existing bridges for bicycle and pedestrian use only, thus allowing the construction of new smaller bridges that do not incorporate non-motorized access and safety measures for these features into the design. Others requested the USACE impose weight restrictions on the Bridges or have one bridge dedicated to freight and commercial traffic use.

One individual mentioned the USACE should consider rebuilding the new bridges in the same location via use of temporary lower bridges constructed adjacent to the existing bridges to minimize permanent impacts to landowners. Many commenters also noted the USACE should continue to maintain the existing bridges as they are and invest in alternative methods of improving access over the Canal. Numerous comments about potential crossing alternatives expressed the belief that the frequency of travel through the Canal by commercial marine vessels requiring significant vertical clearances is minimal, and therefore the cost associated with engineering and constructing taller bridge structures is not fiscally responsible. Individuals also noted that the long ascent and descent associated with the current bridges results in wasteful use of fuel and braking and also believe the grade contributes to motor vehicle accidents during inclement weather. Several commenters also stated that lower and wider bridges, or causeway style crossings should be considered, and larger marine vessels that cannot be accommodated by the lower bridges should be rerouted around Cape Cod.

Response: USACE alternatives are discussed in Section 5.0 of the EA. CEQ regulations require federal agencies to consider a reasonable range of alternatives that meet the purpose and need of a proposed action in their NEPA review. Reasonable alternatives include those that are practical or feasible from a technical and economic standpoint.

Other

Sixty (60) miscellaneous comments were received noting various concerns which included: questions regarding the protocol for snow removal operations within pedestrian and bicycle lanes, concerns with permitting delays due to the involvement of multiple government agencies, questions concerning the fate of the existing railroad bridge, the dimensions and specifications of various new bridge components such as the median, piers and parapets and whether the new design will incorporate renewable energy components such as solar power or hydroelectricity. Other miscellaneous comments included concerns with the current rate of commercial and residential development on and near Cape Cod, including the new proposed casino facility in Wareham, MA, and how construction of the new high-capacity bridge systems will affect the current population trends.

Response: Most of the "other" comments will be addressed in Phase II of the project.

Safety Concerns

Forty-eight (48) individuals cited safety concerns with the existing Bridges and associated roadway infrastructure due to the overall age, the narrow width of the travel lanes, the lack of a median separating opposing travel lanes, the lack of safe bicycle and pedestrian access ways and the need for improved vehicle traffic patterns at associated intersections and rotaries on approach roadways. Commenters stated they feel their safety and well-being are jeopardized by the current Bridges and believe a structural failure resulting in the closing of one of the existing Bridges at any point in the year would cripple Cape Cod's ability to provide support to residents and business owners. Others noted the importance of having a safe and reliable crossing system, should an evacuation of Cape Cod be necessary, and expressed concerns with the placement of support piers within open water sections of the Canal, due to the extent of commercial and recreational boating traffic that occurs annually.

Response: Public health and safety concerns are discussed in Section 6.6.6 of the EA. When the replacement bridges' construction is completed there will be a positive impact on health and public safety.

Climate Change

Thirty-six (36) comments were received requesting the USACE consider climate change, future sea level rise and the potential affects that a 100-year flood event may have on the project area when designing the new bridge systems and associated roadways. Commenters noted the analysis conducted by the USACE is absent of a proper evaluation of potential impacts the project may have on climate change. Many individuals that commented on the effects of climate change feel an expansion in the traffic capacity for the replacement bridges will only induce more motor vehicle travel onto and off of Cape Cod and continue to contribute to the ongoing climate crisis. Individuals requested the USACE incorporate public transit options, such as bus, rail and high occupancy vehicle lanes to encourage the development and necessary expansion of Cape Cod's public transportation networks and reduce local emissions generated by private vehicle use.

Response: The EA discusses climate change in Section 6.1.4. None of the alternatives would have direct or indirect impacts to the climate of the region. Only short duration, minor discharges of carbon-based pollutants would occur during construction activities that could contribute to greenhouse gases.

Impacts to Private Property

Twenty-nine (29) individuals expressed concerns pertaining to the primary and secondary affects the bridge replacement projects will have on residences and businesses that are located within and in the vicinity of the bridge replacement areas. Homeowners that believe they will be directly affected are concerned about the process of eminent domain, how fair market value will be assessed, when compensation will be provided, the timeline of the relocation process, and receiving support and assistance from local, state and federal governments throughout the transition process. Multiple individuals noted concerns with the lack of information about the specific locations selected for the new crossing alignments, and are anxious to view the roads, residences and businesses that will be directly affected by the project.

Individuals located in the vicinity of the Bridges identified concerns related to the secondary affects the project may have on residences and businesses, such as construction related impacts resulting in additional noise, light, and traffic disruptions, and whether compensation for these anticipated disturbances will be provided. Business owners have identified concerns with the potential closing of Exit 1 off Route 6, citing expected revenue losses that would likely result in reduced employment opportunities. Owners of rental properties near the existing bridges have expressed similar concerns and anticipate tenants will be looking to relocate or request reduced rents due to secondary impacts from the project.

Affected residents believe the project, as presented, is overreach by the government, and all feasible design and mitigation measures to minimize impacts to landowners, including construction of the bridges within the same existing footprint should be implemented. One individual noted that following completion of the project, the government should be required to purchase a buffer of property around the perimeter of the new structures so that any future replacement work avoids the displacement of residents and business owners.

Response: Impacts to private property will be addressed during Phase II of the project.

Public Involvement & Communication Concerns

Twenty-six (26) comments were submitted by individuals identifying communication concerns and requests for additional agency collaboration with landowners, municipal offices and various non-government organizations. Numerous individuals that believe they will be directly affected by the replacement projects due to their proximity to the existing Bridges state that they have not been contacted regarding any preliminary project designs, or directly notified of any project meetings. The town of Bourne, MA specifically requested a representative, chosen by the Bourne Board of Selectmen be added to the USACE bridge study committee/team to maintain a direct line of communication between the Town and the USACE throughout the design and construction process. Some commenters stated that the public and municipal offices located on the outer and lower portions of Cape Cod are unaware of the ongoing MassDOT and USACE design work and meetings and wish to be included on any ongoing discussions and preliminary planning related to the bridge replacement project.

The North Sagamore Water District requested to be included on all planning and design work related to the Sagamore Bridge replacement project, and state that the current Draft MRER/EA documents issued by the USACE make no mention of the water department’s infrastructure. The existing approach roadways to the Sagamore Bridge go directly through the water district’s facilities, including crossing of water mains, the District’s two largest producing wells, and a large storage tank. The North Sagamore Water District further commented on the responsibility for the expense to relocate any such utilities and expressed the position that the expense should be incurred by the USACE.

Algonquin Gas Transmission, LLC (a subsidiary of Enbridge, Inc.) also submitted a comment requesting a meeting with USACE regarding the replacement projects and Algonquin’s existing natural gas transmission utility infrastructure located in close proximity to both the Sagamore and the Bourne Bridge. Algonquin notes that while the Draft MRER/EA identifies the existing Algonquin gas pipe adjacent to the Sagamore Bridge, the document does not identify the metering and regulating station adjacent to the Sagamore Bridge, nor the gas pipeline and metering and regulating station adjacent to the Bourne Bridge. Algonquin expressed concern about the need to relocate such utility infrastructure, the associated cost to do so, and the necessary lead time to plan, acquire property rights, prepare and receive necessary permit authorizations for the relocations, and construct the relocated facilities. Algonquin stated that it will be crucial work closely with the USACE on these issues as soon as possible to ensure a positive outcome.

Response: Public involvement and communication concerns are discussed in Section 8.0 and Appendix F of the EA. USACE regulations (the Planning Guidance Notebook – ER 1105-1-100) and the National Environmental Policy Act (NEPA) require that all efforts be made to involve the public in preparing and implementing NEPA procedures and to hold public meetings whenever appropriate (USACE NEPA Implementing Procedures 33 CFR Part 230, CEQ 40 CFR 1500-1508).

Tolls

Sixteen (16) public comments were received regarding the incorporation of a tolling system on the new bridges. Multiple individuals that commented on this subject believe many of Cape Cod's public financial challenges could be relieved by revenue generated from a bridge tolling system. Many are also of the opinion that tolls should only apply to non-resident vehicles that do not work on Cape Cod or the offshore islands. Conversely, some individuals feel all users should be subject to tolls, or that tolls should only apply during peak vacation periods, or only to private vehicle users that are not utilizing carpooling opportunities or public transportation options. Others believe that the addition of a tolling system is not necessary and that travel over the Cape Cod Canal bridges should remain free.

Response: Tolls will be addressed during Phase II of the project.

Historical & Cultural Concerns

Sixteen (16) individuals issued comments requesting the USACE consider keeping the names of the existing bridges and attempt to retain the visual aspects of the current design when engineering the replacement structures. Most commenters feel the bridges are iconic to the Cape Cod region and that new modern cable suspension style systems would contradict the character of the area. One individual commented that if the bridges cannot be saved, an attempt should be made to convert one or both into pedestrian bridges or save portions of the old bridges and put them on display in public locations as exhibits, such that the history of the structures can be preserved for future generations.

Response: EA Section 6.5 discusses historic and archaeological resources. The preferred alternative would have an adverse effect on the bridges and at least two identified archaeological sites, possible unidentified archaeological resources, and several historic districts. The effects would be indirect (visual and/or viewshed) as well as direct (possible archaeological sites). The tribes attended a meeting in March 2019 and concurred with the approach taken in Phase I of the study to evaluate continued repair and maintenance, major rehabilitation, or replacement of the bridges. A formal letter was also sent to the tribes on July 17, 2019. The SHPO concurred with this approach in a letter dated August 22, 2019 (Appendix E). Additional consultation with the SHPO and THPOs on the location of the bridges and the design would be required during Phase II of the project. A Memorandum of Agreement will be developed in consultation with the SHPO, THPOs, MBUAR, and local interested parties during this phase to develop a plan to avoid, minimize, or mitigate the effects of bridge replacement on historic properties. Consultation with the SHPO and tribes is ongoing.

Socioeconomics

Fifteen (15) comments were received pertaining to the potential economic impact that the projects may have on Cape Cod and the surrounding communities. Business owners have identified concerns with the potential closing or re-routing of local roadways, citing anticipated revenue losses and difficulties obtaining goods, which could consequently result in the downsizing of employees and/or the closure of a business. Owners of rental properties in the vicinity of the bridges have expressed similar concerns and anticipate tenants will be looking to relocate or request reduced rents due to project disturbances. Multiple local residents submitted comments requested the USACE evaluate the economic impact of redesign of the northern end of Route 28, as residents feel the re-routing of access roads to accommodate access to the new Bourne Bridge alignment will contribute to this location's economic instabilities.

Response: Socioeconomic effects are evaluated under Section 6.6 of the EA. Construction of the replacement bridges is not expected to have a significant impact on population size or demographic makeup.

Recreational

Thirteen (13) comments were submitted by individuals with concerns about the affects the project may have on recreational activities, as well as suggested design modifications to enhance recreational opportunities, such as bicycling and pedestrian activities along the Canal and surrounding communities. Individuals believe the primary appeal of Cape Cod is its natural resources, which offer an abundance of coastal recreational opportunities. It is believed by residents that allowing additional traffic to visit this location via expansion of the bridges will in turn result in the continued development of Cape Cod putting additional pressure on its natural resources, which are believed to be already overwhelmed by the infrastructure associated with the current population of full-time and seasonal residents. The Bourne Recreation Authority identified that the Bourne Scenic Park and Gallo Ice Arena are both on USACE owned property and have requested the park and rink be identified and maintained during the planning stages of the project.

Response: The EA discusses recreation under Section 6.6.4 in the EA. Construction of the bridges will however require the closure of the canal for 30 days each which will disrupt fishing and boating activities. In addition, there may be other temporary impacts such as portions of the access road will be closed for public use during construction which is projected to last for five years for each bridge.

Tunnel

Twelve (12) individuals requested the USACE consider the construction of one or more tunnels under the Cape Cod Canal as an alternative to the construction of two new bridges. Commenters believe installation of multiple tunnels would ultimately be more cost effective and require less annual maintenance than two elevated roadway structures. Two individuals also requested the USACE contemplate the installation of tunnel systems from the Plymouth, MA area to the middle or outer portions of Cape Cod to alleviate traffic congestion near the Cape Cod Canal.

Response: The tunnel alternative is discussed in Section 5.1.3 of the EA. Tunnels are typically not cost effective when compared to bridge spans that are under a mile in length. Both the Sagamore and Bourne bridges are less than this distance.

Noise and Air Quality

Twelve (12) individuals noted concerns about potential noise related disturbances resulting from project construction and residual noise from automobiles once the new bridges and associated roads are open for travel. Individuals that believe they will incur primary or secondary impacts as a result of the replacement project, requested that the USACE provide specifics pertaining to the alignment of the new bridges and the associated workspaces for the new structures. Commenters noted the agency needs to incorporate dust control measures, noise mitigation methods and adhere to a reasonable work schedule when constructing the projects to minimize impacts to adjacent neighborhoods.

Response: Noise is addressed in Section 6.6.10 of the EA. Air Quality is discussed in Section 6.1.6. Only minor impacts to noise/air quality are anticipated from the preferred alternative.

Timeline of the Project

Ten (10) comments specific to the timeline of the rebuild project have been received to date. Individuals that are in support of the project agree that construction should begin no later than the 2025 start date identified by the USACE, and those that feel they may be directly affected are anxious to receive guidance on how the eminent domain process will be executed.

Response: The project timeline will be developed during Phase II of the study.

Marine Transportation Considerations
Nine (9) comments pertaining to the use of the Canal by commercial marine vessels were submitted. The majority of the individuals that commented on this subject believe the present-day function of the Canal is largely recreational with limited commercial activity, such that the USACE should not be catering the design of the replacement bridges to commercial vessels. Individuals feel the redesign at a maximum should be sized to accommodate the traffic of fuel barges and recreational pleasure crafts, and that the diversion of larger ships around Cape Cod will allow for the construction of lower cost structures, such as causeway style crossings or lower suspension bridges on pilings.

Response: Marine transportation considerations are discussed in Section 6.6.4 of the EA. The USACE is responsible for operating and maintaining the Cape Cod Canal. The primary mission of the Canal is to provide safe navigation to the commercial and recreational vessels that transit the 17.5 mile waterway each year.

EIS and NEPA Process
Seven (7) comments were submitted by three separate individuals regarding the EIS and NEPA permitting process, with one individual submitting 5 separate comments. These commenters identified general comments about the permitting processes, questioning if permitting delays would impact the overall construction schedule, inquired if the USACE evaluated the potential secondary impacts the proposed alternative may have on residents and commuters, questioned if larger capacity bridges would result in additional visitors to Cape Cod and whether MassDOT has evaluated expanding Route 3 to accommodate better traffic flows.

The commenters also identified that they believe the Environmental Assessment fails to address the area-wide social, economic and environmental issues and provides no specific analysis on the affect the proposed alternative may have on residents and individuals that work on Cape Cod. Commenters believe that construction of high capacity bridge crossings will facilitate additional travel to Cape Cod, which consequently will lead to the continued inflation of real-estate values, increased demands on public infrastructure and public services, and result in continued impacts to Cape Cod's natural resource areas. Two of the commenters stated that the USACE should proceed with a full Environmental Impact Statement (EIS) containing the information needed to make a fully informed decision that will consider all aspects and affects the proposed project may have on Cape Cod and its surrounding communities.

Response: The EIS/NEPA process is addressed in Section 2.2 of the EA. NEPA requires Federal agencies to assess the environmental effects of their proposed actions prior to making decisions. The USACE is preparing this Environmental Assessment (EA) pursuant to the White House Council on Environmental Quality (CEQ) Implementing Procedures for NEPA (40 CFR Parts 1500-1508) and USACE Procedures for Implementing NEPA (Engineering Regulation ER-200-2-2).

Third Bridge
Six (6) individual requests were submitted for the USACE to consider the construction of a third bridge to help alleviate traffic and the modification of the existing railroad bridge to allow commuter rail transit onto Cape Cod. One commenter also noted that no portion of the USACE's evaluation report

acknowledges the status of the existing railroad bridge or discusses its future with respect to replacement or as a potential third means of access to Cape Cod.

Response: Section 5.1.2 of the EA discusses the alternative of a third bridge. MassDOT initially studied the concept of a mid- canal crossing, but determined there were significant resource impact issues and this alternative was not carried forward in the MassDOT *Cape Cod Canal Transportation Study* (2019).

Fill the Canal

Six (6) comments on the subject of filling the Canal to facilitate safe, reliable access to Cape Cod were submitted. Individuals believe that filling the Canal would be more cost effective, and that the need to resolve automobile traffic far exceeds the need to account for the perceived minimal commercial marine traffic occurring through the Canal.

Response: Section 5.1.5 of the EA discusses the alternative of filling the canal. The USACE has considered the potential impacts of filling in the canal and has determined this is not a practicable alternative due to the significance of these impacts.

Flood Zones and Flooding

Six (6) public comments have been received to date requesting the USACE account for future sea level rise and the potential affects a 100-year flood event may have on the project area when designing the new bridge systems and associated roadways. Individuals are requesting the USACE account for current floodplain elevations, as well as projected floodplain elevations that could affect bridge locations over the next 50 years.

Response: Floodplains are discussed in Section 6.2.4 of the EA. There will be no significant impact to, or alteration of, floodplains or flood levels associated with any of the alternatives as the both bridges are located within an existing federal navigation channel and adjacent to developed land.

Evacuation Concerns

Five (5) individuals identified they were in favor of the replacement project and categorized the bridges as functionally obsolete, noting the bridges are the only reliable means of exiting Cape Cod during an emergency event. Individuals feel the USACE should design the crossings such that a minimum of three travel lanes are available in each direction to facilitate the swift evacuation of residents during a natural disaster or similar emergency event.

Response: Evacuation concerns are discussed in Section 6.6.6 of the EA. Emergency evacuation of Cape Cod is an important issue due to the high probability of a hazardous event occurring, and because of the high traffic volume and low capacity road conditions that are exacerbated by congestion created by the bridges. Bridge replacement with additional lanes will improve access on and off of Cape Cod during emergency evacuations.

Fisheries

Three (3) comments pertaining to potential impacts to fisheries and recreation fishing were identified. Individuals feel an attempt should be made to create marine habitat at the base of the footings to offset impacts from the installation of support structures within the Cape Cod Canal. Commenters on this subject also noted that they do not support the filling of the Canal, as this area provides a significant volume of recreational fishing opportunities and an abundance of recreational fishing boats use the Canal throughout the year.

Response: Fisheries are discussed in Section 6.4.3 of the EA. The Canal is an important recreational fishery because of its swift currents and connectivity between Buzzards and Cape Cod bays. The Bournedale Herring Run entrance is located about one mile west of the Sagamore Bridge, and provides access for Alewife and Blueback Herring to spawn in Great Herring Pond. Other fish species that may be found in or near the Canal include: striped bass (*Morone saxatilis*), black sea bass (*Centropristis striata*), bluefish (*Pomatomus altatrix*), mackerel (*Scomber scrombrus*), bonito (*Sarda sarda*), tautog (*Tautoga onitis*), scup (*Stenotomus chrysops*), cod (*Gadus morhua*), summer flounder (*Paralichthys dentatus*), and winter flounder (*Pseduopleuronectes americanus*). Measures to avoid, minimize, or mitigate fisheries impacts will be developed in Phase II in consultation with resource agencies.

Threatened and Endangered Species
Three (3) comments pertaining to potential impacts to threatened and endangered species were submitted. Two commenters noted general concerns with potential impacts to marine species. The MA Division of Fisheries and Wildlife (MA DFW) identified the bridge locations are not within Priority Habitat of Rare Species as of the 14th Edition of the Natural Heritage Atlas; however, it was noted that Peregrine Falcons (*Falco peregrinus*) which are a state-listed Threatened species, are known to nest on the bridges and are currently active on the Bourne Bridge. MA DFW noted this species and its habitats are protected pursuant to the MA Endangered Species Act and requested continued coordination with the USACE as the project advances to minimize impacts to nesting falcons and discuss possible proactive opportunities that could be incorporated into final replacement bridge designs.

Response: Threatened and endangered species are addressed in Section 6.4.4 of the EA. The USACE conducted an initial screening of the proposed project site utilizing the US Fish and Wildlife Service (FWS) Information for Planning and Consultation (IPaC) webpage and as well as requesting an official species list from FWS (Appendix I). These records indicate that the federally-threatened northern long-eared bat (NLEB; *Myotis septentrionalis*), endangered northern (Plymouth) red-bellied cooter (*Pseudemys rubriventris*), endangered American chaffseed (*Schwalbea americana*), roseate tern (*Sterna dougalli dougallii*), piping plover (*Chadrius melodus*), and red knot (*Calidris canutus*) may occur in the project area. Consultation with the Services will continue to determine best management practices and/or mitigation measures. A bat survey will occur prior to construction.

Weight Restrictions and Concerns
Three (3) individuals requested the USACE review the load tolerances of the proposed cantilevered pedestrian and bicycle lane to determine if a plow truck could be utilized to remove snow and ice during the winter months.

Response: Weight restrictions will be addressed during Phase II of the project.

Water Quality
Two (2) individuals requested the USACE consider the potential impacts the project may have on Cape Cod's water quality. Commenters on this subject believe that allowing additional traffic to visit Cape Cod via expansion of the bridges will in turn result in the continued development near natural resources, which are believed to already be overwhelmed by the infrastructure associated with the current population of full-time and seasonal residents. Individuals feel the preservation of Cape Cod's single aquifer system must be a priority, and the area's coastal resources are currently overburdened by Cape Cod's population, resulting in overall poor water quality in many bays and estuaries. Commenters believe investing in the inadequate or absent wastewater treatment infrastructure should be the priority on Cape Cod, not the expansion of the existing bridge systems.

Response: Section 6.2.2 of the EA discusses water quality. Replacement as authorized is not anticipated to have any substantial effect on water quality because impacts to regulated water resources would be minimized through avoidance and minimization during the design and construction phase.

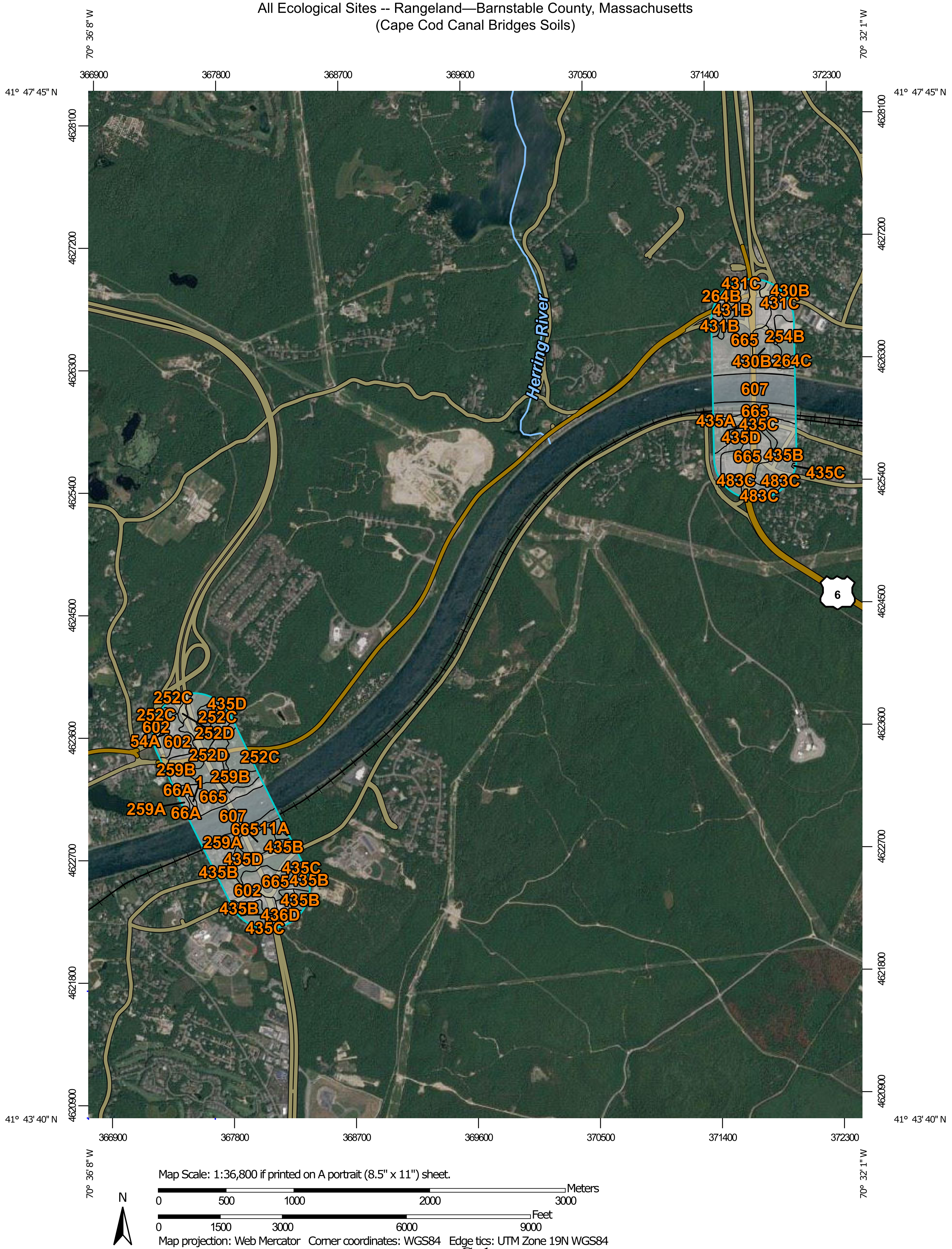
CAPE COD CANAL HIGHWAY BRIDGES
BOURNE, MASSACHUSETTS

MAJOR REHABILITATION EVALUATION REPORT

APPENDIX G
NATURAL RESOURCES CONSERVATION SERVICE SOIL CLASSIFICATION DATA FOR CANAL BRIDGES AREAS

This Page Intentionally Left Blank

All Ecological Sites -- Rangeland—Barnstable County, Massachusetts
(Cape Cod Canal Bridges Soils)



Map Scale: 1:36,800 if printed on A portrait (8.5" x 11") sheet.

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 19N WGS84

MAP LEGEND

Area of Interest (AOI)

☐ Area of Interest (AOI)

Soils

Soil Rating Polygons

▨ R144AY001CT

☐ Not rated or not available

Soil Rating Lines

〰 R144AY001CT

〰 Not rated or not available

Soil Rating Points

■ R144AY001CT

▣ Not rated or not available

Water Features

〰 Streams and Canals

Transportation

┼┼┼ Rails

〰 Interstate Highways

〰 US Routes

〰 Major Roads

〰 Local Roads

Background

▨ Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:25,000.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Barnstable County, Massachusetts
Survey Area Data: Version 15, Sep 5, 2018

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Jul 10, 2018—Nov 17, 2018

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

All Ecological Sites — Rangeland

Map unit symbol	Map unit name	Component name (percent)	Ecological site	Acres in AOI	Percent of AOI
1	Water	Water (100%)		7.6	1.6%
11A	Berryland mucky loamy coarse sand, 0 to 2 percent slopes	Berryland (70%)		4.1	0.8%
		Freetown (10%)			
		Maybid (5%)			
		Pipestone (5%)			
		Swansea (5%)			
		Walpole Variant, LOAMY SUBSTRATUM (5%)			
54A	Freetown and Swansea mucks, coastal lowland, 0 to 1 percent slopes	Freetown, coastal lowland (45%)		8.0	1.7%
		Swansea, coastal lowland (45%)			
		Rainberry, coastal lowland (10%)			
66A	Ipswich - Pawcatuck - Matunuck complex, 0 to 2 percent slopes, very frequently flooded	Ipswich (50%)	R144AY001CT — Tidal Salt Low Marsh mesic very frequently flooded	0.5	0.1%
			R144AY002CT — Tidal Salt High Marsh mesic very frequently flooded		
		Pawcatuck (25%)	R144AY001CT — Tidal Salt Low Marsh mesic very frequently flooded		
			R144AY002CT — Tidal Salt High Marsh mesic very frequently flooded		
		Matunuck (15%)	R144AY001CT — Tidal Salt Low Marsh mesic very frequently flooded		
			R144AY002CT — Tidal Salt High Marsh mesic very frequently flooded		
		Hooksan (5%)			
		Succotash (5%)			

Map unit symbol	Map unit name	Component name (percent)	Ecological site	Acres in AOI	Percent of AOI
252C	Carver coarse sand, 8 to 15 percent slopes	Carver (75%)		24.1	5.0%
		Merrimac (9%)			
		Hinckley (8%)			
		Eastchop (4%)			
		Plymouth (4%)			
252D	Carver coarse sand, 15 to 35 percent slopes	Carver (65%)		22.6	4.7%
		Eastchop (10%)			
		Hinckley (10%)			
		Plymouth (10%)			
		Freetown (3%)			
		Swansea (2%)			
254B	Merrimac fine sandy loam, 3 to 8 percent slopes	Merrimac (85%)		8.6	1.8%
		Hinckley (5%)			
		Sudbury (5%)			
		Windsor (3%)			
		Agawam (2%)			
256A	Deerfield loamy fine sand, 0 to 3 percent slopes	Deerfield (85%)		2.0	0.4%
		Windsor (7%)			
		Wareham (5%)			
		Sudbury (2%)			
		Ninigret (1%)			
259A	Carver loamy coarse sand, 0 to 3 percent slopes	Carver (80%)		19.2	4.0%
		Hinckley (6%)			
		Merrimac (6%)			
		Eastchop (4%)			
		Enfield (4%)			
259B	Carver loamy coarse sand, 3 to 8 percent slopes	Carver (80%)		21.7	4.5%
		Hinckley (6%)			
		Merrimac (6%)			
		Eastchop (4%)			
		Enfield (4%)			
264A	Eastchop loamy fine sand, 0 to 3 percent slopes	Eastchop (75%)		2.5	0.5%
		Hinckley (8%)			
		Merrimac (7%)			
		Carver (5%)			
		Enfield (5%)			
264B	Eastchop loamy fine sand, 3 to 8 percent slopes	Eastchop (75%)		0.2	0.0%
		Hinckley (8%)			

Map unit symbol	Map unit name	Component name (percent)	Ecological site	Acres in AOI	Percent of AOI
		Merrimac (7%)			
		Carver (5%)			
		Enfield (5%)			
264C	Eastchop loamy fine sand, 8 to 15 percent slopes	Eastchop (70%)		0.6	0.1%
		Carver (10%)			
		Hinckley (10%)			
		Merrimac (5%)			
		Plymouth (5%)			
430B	Barnstable sandy loam, 3 to 8 percent slopes	Barnstable (75%)		14.0	2.9%
		Plymouth (8%)			
		Nantucket (7%)			
		Carver (5%)			
		Merrimac (5%)			
431B	Barnstable sandy loam, 3 to 8 percent slopes, very stony	Barnstable (75%)		6.7	1.4%
		Plymouth (10%)			
		Nantucket (8%)			
		Carver (7%)			
431C	Barnstable sandy loam, 8 to 15 percent slopes, very stony	Barnstable (70%)		14.2	2.9%
		Carver (10%)			
		Nantucket (10%)			
		Plymouth (10%)			
431D	Barnstable sandy loam, 15 to 25 percent slopes, very stony	Barnstable (65%)		3.8	0.8%
		Plymouth (10%)			
		Nantucket (9%)			
		Carver (8%)			
		Hinckley (8%)			
435A	Plymouth loamy coarse sand, 0 to 3 percent slopes	Plymouth (70%)		0.3	0.1%
		Barnstable (9%)			
		Carver (9%)			
		Hinckley (9%)			
		Merrimac (3%)			
435B	Plymouth loamy coarse sand, 3 to 8 percent slopes	Plymouth (70%)		35.1	7.2%
		Carver (8%)			
		Hinckley (8%)			
		Barnstable (6%)			
		Nantucket (6%)			
		Merrimac (2%)			
435C	Plymouth loamy coarse sand, 8 to	Plymouth (65%)		12.7	2.6%

Map unit symbol	Map unit name	Component name (percent)	Ecological site	Acres in AOI	Percent of AOI
	15 percent slopes	Carver (15%)			
		Hinckley (8%)			
		Barnstable (6%)			
		Nantucket (6%)			
435D	Plymouth loamy coarse sand, 15 to 35 percent slopes	Plymouth (65%)		25.0	5.1%
		Carver (15%)			
		Hinckley (10%)			
		Barnstable (5%)			
		Nantucket (5%)			
436D	Plymouth loamy coarse sand, 15 to 35 percent slopes, very stony	Plymouth (65%)		6.1	1.3%
		Carver (15%)			
		Hinckley (10%)			
		Barnstable (5%)			
		Nantucket (5%)			
483C	Plymouth-Barnstable complex, rolling, very bouldery	Plymouth (55%)		3.1	0.6%
		Barnstable (20%)			
		Carver (10%)			
		Hinckley (10%)			
		Nantucket (5%)			
484D	Plymouth-Barnstable complex, hilly, extremely bouldery	Plymouth (55%)		9.4	1.9%
		Barnstable (20%)			
		Nantucket (10%)			
		Carver (5%)			
		Hinckley (5%)			
		Merrimac (5%)			
600	Pits, sand and gravel	Pits (100%)		7.3	1.5%
602	Urban land	Urban land (85%)		28.9	6.0%
		Udipsamments (15%)			
607	Water, saline	Water, saline (100%)		62.4	12.9%
665	Udipsamments, smoothed	Udipsamments (100%)		134.0	27.6%
Totals for Area of Interest				**484.9**	**100.0%**

CAPE COD CANAL HIGHWAY BRIDGES
BOURNE, MASSACHUSETTS

MAJOR REHABILITATION EVALUATION REPORT

APPENDIX H
PRELIMINARY COASTAL ZONE MANAGEMENT CONSISTENCY DETERMINATION

This Page Intentionally Left Blank

DEPARTMENT OF THE ARMY
US ARMY CORPS OF ENGINEERS
NEW ENGLAND DISTRICT
696 VIRGINIA ROAD
CONCORD MA 01742-2751

July 1, 2019

Programs & Project Management Division
Civil Works/IIS Project Management Branch

Mr. Robert Boeri
Project Review Coordinator
Massachusetts Office of Coastal Zone Management
251 Causeway Street, Suite 800
Boston, Massachusetts 02114-2138

Dear Mr. Boeri:

I am writing to inform you that the U.S. Army Corps of Engineers (Corps), New England District is proposing to either rehabilitate or replace the Bourne and Sagamore Bridges (Attachments 1-3). The purpose of the Cape Cod Canal Bourne and Sagamore Bridges Phase I Major Rehabilitation Evaluation Study and resultant decision document is to determine whether restoring or replacing the existing deteriorated bridges will provide more efficient and effective structures which will maintain reliability of service, improve safety and ease of maintenance, and provide safe, secure, and cost effective access across the Cape Cod Canal.

The existing bridges were designed and built in the 1930s and do not meet current highway safety standards or adequately reflect modern-day traffic conditions. Traffic volumes have increased since the bridges were originally constructed, leading to significant increased loading and demands on the bridges' infrastructure. Routine maintenance will not be able to keep pace with current traffic and loading demands.

Pursuant to the Coastal Zone Management Act, I am requesting that your office review Phase I of the proposed project for preliminary consistency with the Massachusetts Coastal Zone Management Program. It is the Corps' determination that the proposed Phase I work is consistent to the maximum extent practicable with the enforceable policies of the approved Massachusetts Coastal Zone Management Program and will be undertaken in a manner consistent with those policies. A Determination of Federal Consistency forming the basis of our determination is attached for your review.

Please provide your concurrence with our preliminary consistency determination within 60 days of receipt of this letter. If you or your staff have any questions or require additional information, please feel free to contact myself at (978) 318-8638 or Rosemarie Bradley, Environmental Resources Team Member at (978) 318-8127.

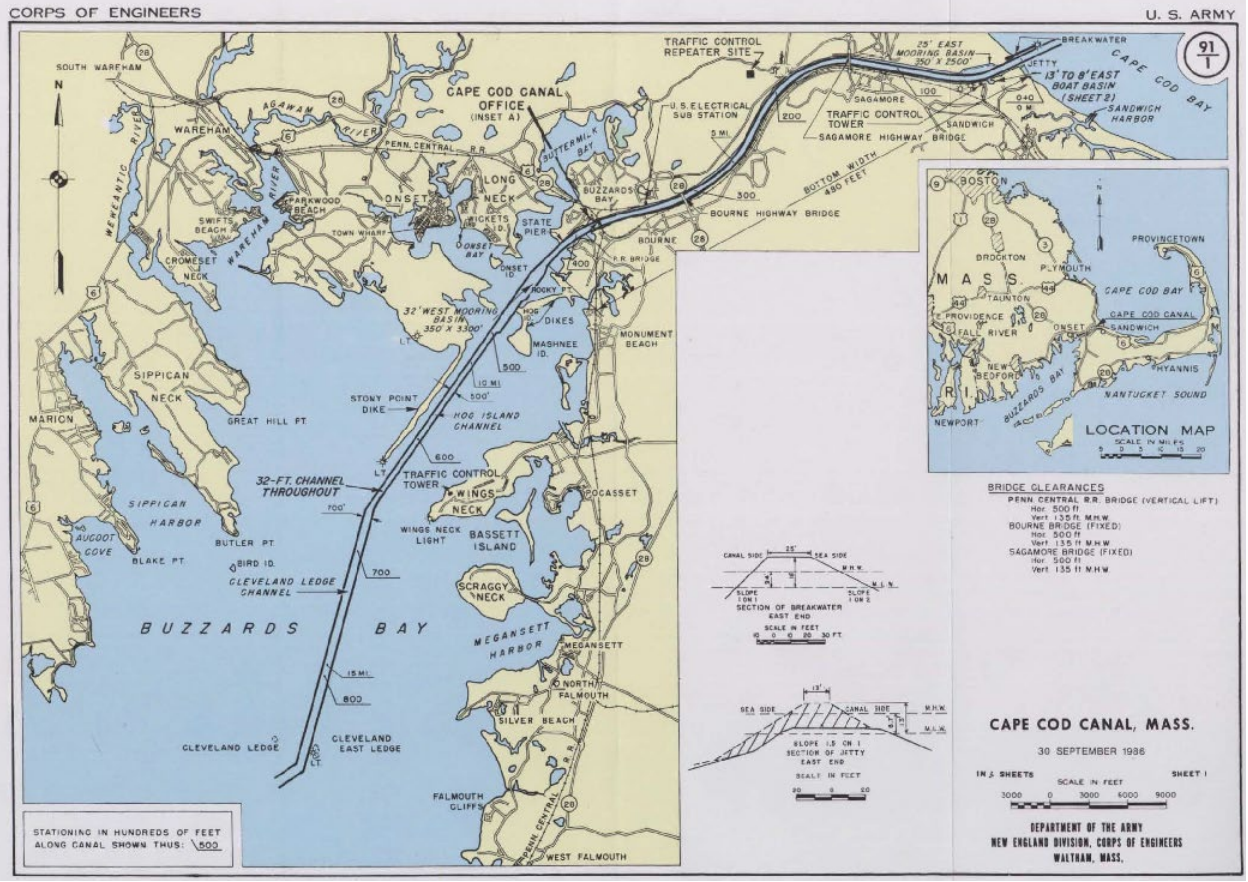
Sincerely,

Craig Martin
Project Manager
Navigation Section

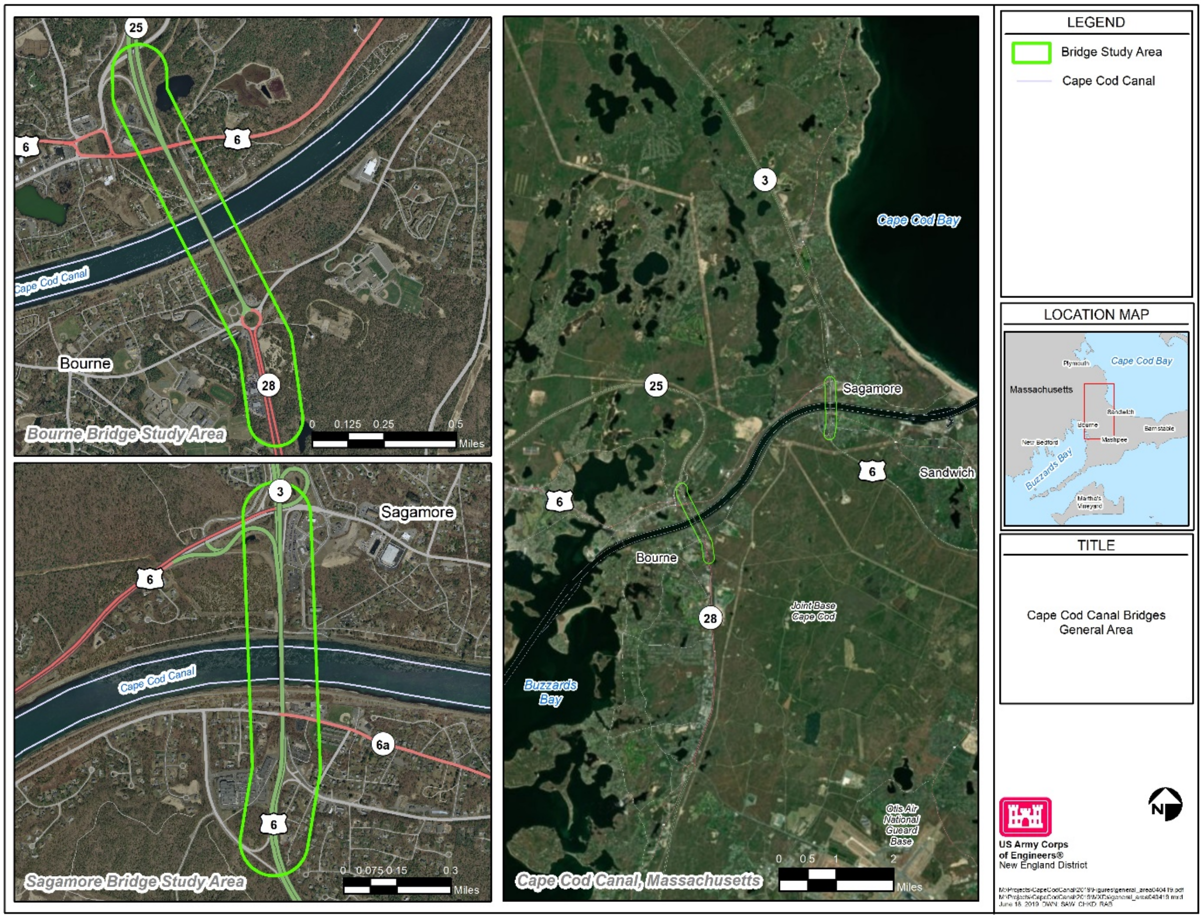
Encl.
Determination of Federal Consistency

CC:
Mr. Stephen McKenna
CZM Cape Cod and Islands Regional Coordinator
P.O. Box 220
Barnstable, MA 02630-0220

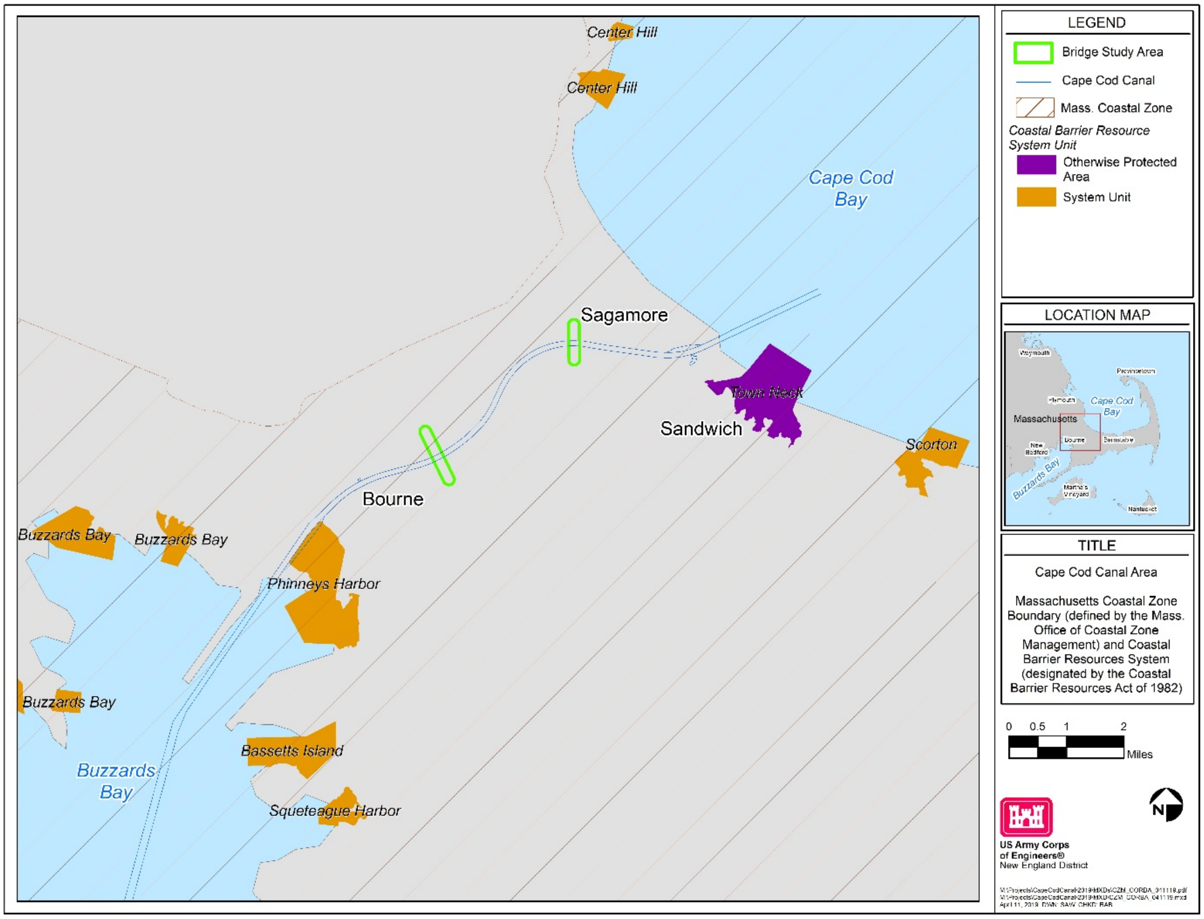
ATTACHMENT 1 – Location of the Cape Cod Canal



ATTACHMENT 2 – General Project Study Area



ATTACHMENT 3 – Coastal Zones and Coastal Barrier Resources System



Coastal Zone Management Preliminary Consistency Determination
Cape Cod Canal Bridges Project
August 2019

COASTAL HAZARD POLICY #1 - Preserve, protect, restore, and enhance the beneficial functions of storm damage prevention and flood control provided by natural coastal landforms, such as dunes, beaches, barrier beaches, coastal banks, land subject to coastal storm flowage, salt marshes, and land under the ocean.

CONSISTENCY Both the Sagamore and Bourne bridges are located within Zones X (0.2% annual chance of flooding) and AE (1% annual chance of flooding, with BFE). Maintenance of these existing bridges will have no impact on existing floodplain functions. Should replacement of the existing bridges be the recommended alternative all efforts will be made to incorporate features that will serve to avoid and minimize impacts to existing floodplain functions.

COASTAL HAZARD POLICY #2 - Ensure construction in water bodies and contiguous land areas will minimize interference with water circulation and sediment transport. Approve permits for flood or erosion control projects only when it has been determined that there will be no significant adverse effects on the project site or adjacent or down coast areas.

CONSISTENCY Any future repair or maintenance activities will be coordinated with affected resource agencies to ensure minimization of impacts to water circulation and sediment transport. All actions supporting a bridge replacement alternative will be fully coordinated with affected resource agencies during the design phase to ensure minimization of impacts in addition to incorporating Best Management Practices (BMPs) during construction. Any temporary or permanent features of the new bridges will likely have minimal impacts to canal flow. A Stormwater Management plan will be developed and BMPs will be employed to minimize and contain any sediment runoff during Phase II of the project (Design and Construction Phase).

COASTAL HAZARD POLICY #3 - Ensure that state and federally funded public works projects proposed for location within the coastal zone will:

- not exacerbate existing hazards or damage natural buffers or other natural resources,
- be reasonably safe from flood and erosion related damage, and
- not promote growth and development in hazard-prone or buffer areas, especially in Velocity zones and ACECs, and
- not be used on Coastal Barrier Resource Units for new or substantial reconstruction of structures in a manner inconsistent with the Coastal Barrier Resource/Improvement Acts.

CONSISTENCY Activities related to either the repair or replacement of the existing bridges will not exacerbate existing hazards and appropriate measures will be incorporated into the design to ensure that the project will be safe from flood and erosion related damage. Bridge rehabilitation or replacement will not promote development in hazard-prone areas and are not located within Coastal Barrier Resource Units.

COASTAL HAZARD POLICY #4 - Prioritize public funds for acquisition of hazardous coastal areas for conservation or recreation use, and relocation of structures out of coastal high hazard areas, giving due consideration to the effects of coastal hazards at the location to the use and manageability of the area.

CONSISTENCY   This policy is not applicable.

ENERGY POLICY #1 - For coastally dependent energy facilities, consider siting in alternative coastal locations. For non-coastally dependent energy facilities, consider siting in areas outside of the coastal zone. Weigh the environmental and safety impacts of locating proposed energy facilities at alternative sites.

CONSISTENCY   This policy is not applicable.

ENERGY POLICY #2 - Encourage energy conservation and the use of alternative sources such as solar and wind power in order to assist in meeting the energy needs of the Commonwealth.

CONSISTENCY   This policy is not applicable.

GROWTH MANAGEMENT POLICY #1 – Encourage sustainable development that is consistent with state, regional, and local plans and supports the quality and character of the community.

CONSISTENCY   The MassDOT Cape Cod Canal Transportation Study (2019) has identified replacement bridges as being integral to road infrastructure improvement projects. The project supports state, regional and local plans for sustainable development. The project’s intent is to allow for the development and operation of a project that will not reduce the quality or character of the surrounding community. Therefore, the project is consistent with this policy.

GROWTH MANAGEMENT POLICY #2 - Ensure that state and federally funded transportation and wastewater projects primarily serve existing developed areas, assigning highest priority to projects that meet the needs of urban and community development centers.

CONSISTENCY   The project primarily serves existing developed areas and will serve to meet the needs of urban and community development centers by providing a more efficient and safe system for vehicular transport across the Cape Cod canal. The Bourne and Sagamore Bridges provide the only vehicular access to 15 towns and nearly 215,000 full time residents and millions of annual visitors to Cape Cod. The bridges also provide access to 8 offshore island municipalities through the ferry terminals located on Cape Cod. Safe replacement bridges will supply the only access for residents, commuters and visitors. Therefore, the project is consistent with this policy.

GROWTH MANAGEMENT POLICY #3 - Encourage the revitalization and enhancement of existing development centers in the coastal zone through technical assistance and federal and state financial support for residential, commercial and industrial development.

CONSISTENCY This policy is not applicable.

HABITAT POLICY #1 - Protect coastal, estuarine, and marine habitats—including salt marshes, shellfish beds, submerged aquatic vegetation, dunes, beaches, barrier beaches, banks, salt ponds, eelgrass beds, tidal flats, rocky shores, bays, sounds, and other ocean habitats—and coastal freshwater streams, ponds, and wetlands to preserve critical wildlife habitat and other important functions and services including nutrient and sediment attenuation, wave and storm damage protection, and landform movement and processes.

CONSISTENCY The purpose of this phase of the project is to determine whether repair or replacement of the existing bridges is the most economically and environmentally viable alternative to ensure vehicular transport across the Cape Cod Canal. It is not anticipated that any activities associated with repair or rehabilitation of these bridges will have negative impacts on the above-described resources given that they are existing structures and that BMP practices will be incorporated during construction activities to minimize impacts to the surrounding environment. It is anticipated that Bridge replacement will likely entail the removal and re-location of existing support structures and piers within the canal to an upland setting, reducing the overall project footprint in the Canal itself. The piers from the old bridges will also be removed from the canal waters following completion of the newly constructed bridges thus reducing the overall footprint in subtidal areas. In addition, the shoreline where the piers are currently situated are shallow areas hardened with rip-rap for operation and maintenance of the Canal. Impacts during removal activities will be temporary and localized in nature, and actually reduce the in-water footprint of the bridges structures. BMPs will be used during the entire removal process to avoid and minimize impacts to the surrounding environment. Therefore, the project is consistent with the policy.

HABITAT POLICY #2 - Advance the restoration of degraded or former habitats in coastal and marine areas.

CONSISTENCY Not applicable. Project is for the either the repair or replacement of existing bridges.

OCEAN RESOURCES POLICY #1 - Support the development of sustainable aquaculture, both for commercial and enhancement (public shellfish stocking) purposes. Ensure that the review process regulating aquaculture facility sites (and access routes to those areas) protects significant ecological resources (salt marshes, dunes, beaches, barrier beaches, and salt ponds) and minimizes adverse effects on the coastal and marine environment and other water-dependent uses.

CONSISTENCY The policy is not applicable.

OCEAN RESOURCES POLICY #2 - Except where such activity is prohibited by the Ocean Sanctuaries Act, the Massachusetts Ocean Management Plan, or other applicable provision of law, the extraction of oil, natural gas, or marine minerals (other than sand and gravel) in or affecting the coastal zone must protect marine resources, marine water quality, fisheries, and navigational, recreational and other uses.

CONSISTENCY The policy is not applicable.

OCEAN RESOURCES POLICY #3 - Accommodate offshore sand and gravel mining needs in areas and in ways that will not adversely affect shoreline areas due to alteration of wave direction and dynamics, marine resources and navigation. Mining of sand and gravel, when and where permitted, will be primarily for the purpose of beach nourishment.

CONSISTENCY The policy is not applicable.

PORTS AND HARBORS POLICY #1 - Ensure that dredging and disposal of dredged material minimize adverse effects on water quality, physical processes, marine productivity, and public health and take full advantage of opportunities for beneficial re-use.

CONSISTENCY This policy is not applicable. It is not anticipated that any dredging will be required for either the repair or replacement of bridges.

PORTS AND HARBORS POLICY #2 - Obtain the widest possible public benefit from channel dredging and ensure that Designated Port Areas and developed harbors are given highest priority in the allocation of resources.

CONSISTENCY The policy is not applicable. No dredging will be required for replacement of bridges.

PORTS AND HARBORS POLICY #3 - Preserve and enhance the capacity of Designated Port Areas to accommodate water-dependent industrial uses and prevent the exclusion of such uses from tidelands and any other DPA lands over which an EEA agency exerts control by virtue of ownership or other legal authority.

CONSISTENCY This policy is not applicable.

PORTS AND HARBORS POLICY #4 - For development on tidelands and other coastal waterways, preserve and enhance the immediate waterfront for vessel-related activities that require sufficient space and suitable facilities along the water's edge for operational purposes.

CONSISTENCY The project will preserve the immediate waterfront for vessel-related activities and is therefore consistent with this policy. This project involves replacement of two existing bridges.

PORTS AND HARBORS POLICY #5 - Encourage, through technical and financial assistance, expansion of water-dependent uses in Designated Port Areas and developed harbors, re-development of urban waterfronts, and expansion of physical and visual access.

CONSISTENCY This policy is not applicable.

PROTECTED AREAS POLICY #1 - Preserve, restore, and enhance coastal Areas of Critical Environmental Concern, which are complexes of natural and cultural resources of regional or statewide significance.

CONSISTENCY: Repair and Rehabilitation Alternative: No impacts will be realized to Areas of Critical Environmental Concern from the repair or rehabilitation of the existing Bridge structures. Incorporation of BMPs will ensure minimization and avoidance of impacts to the surrounding environment.

Replacement: The Herring River ACEC abuts the northwestern corner of the project footprint of the Sagamore replacement bridge. USACE will make every effort to ensure no impact to the ACEC during design phase of the Project.

PROTECTED AREAS POLICY #2 - Protect state and locally designated scenic rivers and state classified scenic rivers in the coastal zone.

CONSISTENCY No scenic rivers will be impacted by this project; thus, the policy is not applicable.

PROTECTED AREAS POLICY #3 - Ensure that proposed developments in or near designated or registered historic districts or sites respect the preservation intent of the designation and that potential adverse effects are minimized.

CONSISTENCY Coordination with the State Historic Preservation Office is ongoing to ensure compliance with applicable regulations.

PUBLIC ACCESS POLICY #1 - Ensure that development (both water-dependent and nonwater-dependent) of coastal sites subject to state waterways regulation will promote general public use and enjoyment of the water’s edge, to an extent commensurate with the Commonwealth’s interests in flowed and filled tidelands under the Public Trust Doctrine.

CONSISTENCY There will be temporary impacts to recreational areas along the Canal from either the repair, rehabilitation or replacement of the bridges during certain project phases. All activities will be appropriately coordinated with state, local and Federal entities to minimize impacts during construction activities and to maintain a safe environment. However, upon, completion, the project will promote public use and enjoyment of the water’s edge by providing multimodal recreational paths created by installation of replacement bridges and is therefore consistent with this policy. Walking/biking paths are being considered as part of project development plans, which would enhance the public’s use and enjoyment of the Cape Cod Canal.

PUBLIC ACCESS POLICY #2 - Improve public access to existing coastal recreation facilities and alleviate auto traffic and parking problems through improvements in public transportation and trail links (land- or water-based) to other nearby facilities. Increase capacity of existing recreation areas by facilitating multiple use and by improving management, maintenance, and public support facilities. Ensure that the adverse impacts of developments proposed near existing public access and recreation sites are minimized.

CONSISTENCY There will be temporary impacts to recreational areas along the Canal from either the repair, rehabilitation or replacement of the bridges during certain project phases. The proposed project would have no permanent impacts on recreation except to promote access to other recreation areas on Cape Cod and Massachusetts Islands and alleviate auto traffic problems through improvements in public transportation. It is therefore consistent with this policy. Walking/biking paths are being considered as part of project development plans, which would enhance the public's use and enjoyment of the Cape Cod Canal across the replacement bridges.

PUBLIC ACCESS POLICY #3 - Expand existing recreation facilities and acquire and develop new public areas for coastal recreational activities, giving highest priority to regions of high need or limited site availability. Provide technical assistance to developers of both public and private recreation facilities and sites that increase public access to the shoreline to ensure that both transportation access and the recreation facilities are compatible with social and environmental characteristics of surrounding communities.

CONSISTENCY There will be minor temporary impacts to recreational areas along the Canal from this project. However, it expands recreational areas by adding walking/biking lanes on both the Sagamore and Bourne bridges and is therefore consistent with this policy.

WATER QUALITY POLICY #1 - Ensure that point-source discharges and withdrawals in or affecting the coastal zone do not compromise water quality standards and protect designated uses and other interests.

CONSISTENCY A Stormwater Management Plan will be developed during the design and construction phase (Phase II) in conformance with USACE policy and goals/design standards with those established by MA DEP Stormwater Management Regulations (310 CMR 10.05K).

WATER QUALITY POLICY #2 - Ensure the implementation of nonpoint source pollution controls to promote the attainment of water quality standards and protect designated uses and other interests.

CONSISTENCY The construction of the proposed project will be performed using BMPs to control non-point pollution sources. Therefore, the project is consistent with the policy.

WATER QUALITY POLICY #3 - Ensure that subsurface waste discharges conform to applicable standards, including the siting, construction, and maintenance requirements for on-site wastewater disposal systems, water quality standards, established Total Maximum Daily Load limits, and prohibitions on facilities in high-hazard areas.

CONSISTENCY This policy is not applicable.

This Page Left Intentionally Blank

CAPE COD CANAL HIGHWAY BRIDGES
BOURNE, MASSACHUSETTS

MAJOR REHABILITATION EVALUATION REPORT

APPENDIX I
U.S. FISH AND WILDLIFE SERVICE
THREATENED AND ENDANGERED SPECIES
SPECIES LIST

This Page Intentionally Left Blank

United States Department of the Interior

FISH AND WILDLIFE SERVICE
New England Ecological Services Field Office
70 Commercial Street, Suite 300
Concord, NH 03301-5094
Phone: (603) 223-2541 Fax: (603) 223-0104
http://www.fws.gov/newengland

In Reply Refer To: February 08, 2019
Consultation Code: 05E1NE00-2019-SLI-0855
Event Code: 05E1NE00-2019-E-01963
Project Name: Cape Cod Canal Bridges MRER

Subject: List of threatened and endangered species that may occur in your proposed project location, and/or may be affected by your proposed project

To Whom It May Concern:

The enclosed species list identifies threatened, endangered, proposed and candidate species, as well as proposed and final designated critical habitat, that may occur within the boundary of your proposed project and/or may be affected by your proposed project. The species list fulfills the requirements of the U.S. Fish and Wildlife Service (Service) under section 7(c) of the Endangered Species Act (Act) of 1973, as amended (16 U.S.C. 1531 *et seq.*).

New information based on updated surveys, changes in the abundance and distribution of species, changed habitat conditions, or other factors could change this list. Please feel free to contact us if you need more current information or assistance regarding the potential impacts to federally proposed, listed, and candidate species and federally designated and proposed critical habitat. Please note that under 50 CFR 402.12(e) of the regulations implementing section 7 of the Act, the accuracy of this species list should be verified after 90 days. This verification can be completed formally or informally as desired. The Service recommends that verification be completed by visiting the ECOS-IPaC website at regular intervals during project planning and implementation for updates to species lists and information. An updated list may be requested through the ECOS-IPaC system by completing the same process used to receive the enclosed list.

The purpose of the Act is to provide a means whereby threatened and endangered species and the ecosystems upon which they depend may be conserved. Under sections 7(a)(1) and 7(a)(2) of the Act and its implementing regulations (50 CFR 402 *et seq.*), Federal agencies are required to utilize their authorities to carry out programs for the conservation of threatened and endangered species and to determine whether projects may affect threatened and endangered species and/or designated critical habitat.

A Biological Assessment is required for construction projects (or other undertakings having similar physical impacts) that are major Federal actions significantly affecting the quality of the human environment as defined in the National Environmental Policy Act (42 U.S.C. 4332(2)(c)). For projects other than major construction activities, the Service suggests that a biological evaluation similar to a Biological Assessment be prepared to determine whether the project may affect listed or proposed species and/or designated or proposed critical habitat. Recommended contents of a Biological Assessment are described at 50 CFR 402.12.

If a Federal agency determines, based on the Biological Assessment or biological evaluation, that listed species and/or designated critical habitat may be affected by the proposed project, the agency is required to consult with the Service pursuant to 50 CFR 402. In addition, the Service recommends that candidate species, proposed species and proposed critical habitat be addressed within the consultation. More information on the regulations and procedures for section 7 consultation, including the role of permit or license applicants, can be found in the "Endangered Species Consultation Handbook" at:

http://www.fws.gov/endangered/esa-library/pdf/TOC-GLOS.PDF

Please be aware that bald and golden eagles are protected under the Bald and Golden Eagle Protection Act (16 U.S.C. 668 *et seq.*), and projects affecting these species may require development of an eagle conservation plan (http://www.fws.gov/windenergy/eagle_guidance.html). Additionally, wind energy projects should follow the wind energy guidelines (http://www.fws.gov/windenergy/) for minimizing impacts to migratory birds and bats.

Guidance for minimizing impacts to migratory birds for projects including communications towers (e.g., cellular, digital television, radio, and emergency broadcast) can be found at: http://www.fws.gov/migratorybirds/CurrentBirdIssues/Hazards/towers/towers.htm; http://www.towerkill.com; and http://www.fws.gov/migratorybirds/CurrentBirdIssues/Hazards/towers/comtow.html.

We appreciate your concern for threatened and endangered species. The Service encourages Federal agencies to include conservation of threatened and endangered species into their project planning to further the purposes of the Act. Please include the Consultation Tracking Number in the header of this letter with any request for consultation or correspondence about your project that you submit to our office.

Attachment(s):

- Official Species List

Official Species List

This list is provided pursuant to Section 7 of the Endangered Species Act, and fulfills the requirement for Federal agencies to "request of the Secretary of the Interior information whether any species which is listed or proposed to be listed may be present in the area of a proposed action".

This species list is provided by:

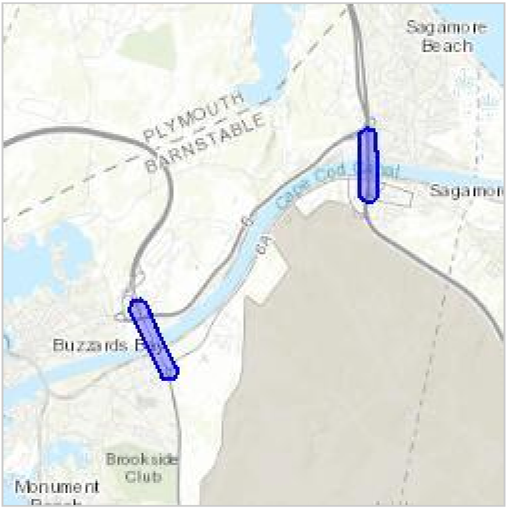
New England Ecological Services Field Office
70 Commercial Street, Suite 300
Concord, NH 03301-5094
(603) 223-2541

Project Summary

Consultation Code:	05E1NE00-2019-SLI-0855
Event Code:	05E1NE00-2019-E-01963
Project Name:	Cape Cod Canal Bridges MRER
Project Type:	BRIDGE CONSTRUCTION / MAINTENANCE
Project Description:	Evaluation to see whether major rehabilitation or replacement is needed for Cape Cod Canal Bridges.

Project Location:

Approximate location of the project can be viewed in Google Maps: https://www.google.com/maps/place/41.748195406606555N70.58981170119783W



Counties: Barnstable, MA

Endangered Species Act Species

There is a total of 3 threatened, endangered, or candidate species on this species list.

Species on this list should be considered in an effects analysis for your project and could include species that exist in another geographic area. For example, certain fish may appear on the species list because a project could affect downstream species.

IPaC does not display listed species or critical habitats under the sole jurisdiction of NOAA Fisheries[1], as USFWS does not have the authority to speak on behalf of NOAA and the Department of Commerce.

See the "Critical habitats" section below for those critical habitats that lie wholly or partially within your project area under this office's jurisdiction. Please contact the designated FWS office if you have questions.

---

1. NOAA Fisheries, also known as the National Marine Fisheries Service (NMFS), is an office of the National Oceanic and Atmospheric Administration within the Department of Commerce.

Mammals

NAME	STATUS
Northern Long-eared Bat *Myotis septentrionalis* No critical habitat has been designated for this species. Species profile: https://ecos.fws.gov/ecp/species/9045	Threatened

Birds

NAME	STATUS
Roseate Tern *Sterna dougallii dougallii* Population: northeast U.S. nesting pop. No critical habitat has been designated for this species. Species profile: https://ecos.fws.gov/ecp/species/2083	Endangered

Reptiles

NAME	STATUS
Plymouth Redbelly Turtle *Pseudemys rubriventris bangsi* There is **final** critical habitat for this species. Your location is outside the critical habitat. Species profile: https://ecos.fws.gov/ecp/species/451	Endangered

Critical habitats

THERE ARE NO CRITICAL HABITATS WITHIN YOUR PROJECT AREA UNDER THIS OFFICE'S JURISDICTION.

CAPE COD CANAL HIGHWAY BRIDGES

BOURNE, MASSACHUSETTS

MAJOR REHABILITATION EVALUATION REPORT

APPENDIX J

REAL ESTATE

This Page Intentionally Left Blank

DEPARTMENT OF THE ARMY
US ARMY CORPS OF ENGINEERS
New England District
696 Virginia Road
Concord, MA 01742-2751

CENAE-RE-A

MEMORANDUM OF RECORD
Cape Cod Bridge Project Real Estate Planning Report

DATE: 15 February 2020 (Prior Update 15 January 2020, 5 August 2019)

FROM:
Department of the Army
United States Army Corps of
Engineers New England
District NAE
Real Estate Division
696 Virginia Road, Concord, MA 01742-2751

TO:
Department of the Army
United States Army Corps of
Engineers New England
District NAE
CCC Bridges Replacement Bridge Plan Team
696 Virginia Road, Concord, MA 1742-2751

SUBJECT: Bridge Project Real Estate Plan Report Real Estate Cost Estimate, dated 15 January 2020. Request and Scope of this assignment is to perform a preliminary cost estimate on the “Bourne Bridge and Sagamore Bridge Replacement Project,” based on land area estimates, from the August 2019, Bourne Bridge and Sagamore Bridge Replacement Plan, attached, along with Google Earth**.** The “Utility Relocation” cost, which is not included will be provided as a separate Cost Estimate with Design and Construction costs. It should be recognized all utilities have cancellable easement or license instruments, as listed in the Addenda. The “Rough Order of Magnitude” is considered reasonable at this stage of conceptual design, with acreage estimated for an easement and acquisition estimate. The twenty-One Points as outlined in a REPR was considered with no adverse comments regarding the categories involved. This MOR has emphasis on the Cost Estimate for this stage of feasibility planning purposes.

1) Project Data:

Effective date 15 January 2020 prior site inspection on 25 May 2016 (photographs on shared drive), review of the Bourne Bridge and Sagamore Bridge Replacement Plan, Google Map review and GIS Parcel overview for estimating locations at time of inspection.

A) Project Name: Bourne Bridge and Sagamore Bridge Replacement Plan Project, as referenced for this preliminary real estate cost estimate.
B) Tract Number: Referenced as Bourne Bridge, Map 24 Parcels 7, 13-17, 19, 22, 23, 25, and 42-44. Sagamore Bridge, Map 11.4 Parcels 6, 46, 47, 52 and 55, other ancillary sites have nominal impact and off-set by project benefits. A definitive engineering plan may change the impact areas.
C) Assignment Conditions: The areas provided in this report have been established by estimating measures from Google Earth and Assessor maps. The measurements are based on estimates and considered a test of reasonableness.
D) The engineered measurements of the Parcels will be provided for specific easement areas and the cost estimate adjusted at that time, when engineered areas of the Parcels become available. Relocation for Dunkin Donuts, retail center and the Market Basket center, is considered in this analysis. The “Rough Order of Magnitude” is considered reasonable at this stage of conceptual design, with acreage estimated for an easement and acquisition estimate.

2) Ownership Data:

The properties along the approaches based on this plan shown below and throughout this report, suggests some significant impacts on property on the Cape side of both bridges, as cited by the Bridge Modifications & Approaches Outline in the Addenda. The location has varied commercial and/or institutional property and would be delineated for individual Parcel valuations at time of the appraisal and valuation process.

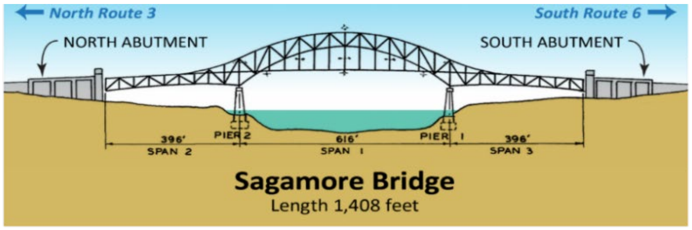
3) Property Data:

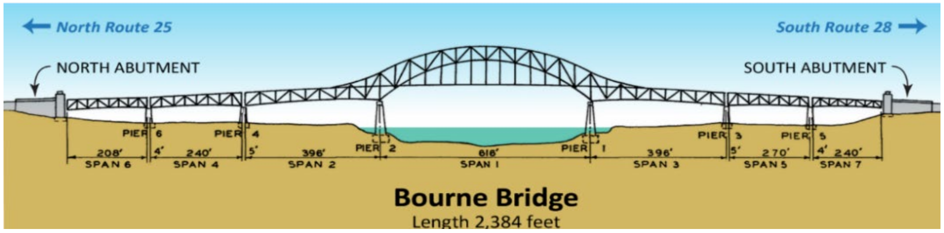
Property Location: The property is composed of varied parcel ownerships and sizes. The concept of the summation of the areas, delineated by use, involves property along the approaches of both bridges. The subject is located around mostly commercial and institutional type properties.

4) Project Description:

The subject property is a portion of land holdings owned by USACE Cape Cod Canal District, located at the USACE Cape Cod Canal District, Bourne, MA. The Army Corps of Engineers owns the Canal, and continuous sections of land on both the east and west sides.

EXISTING SPANS





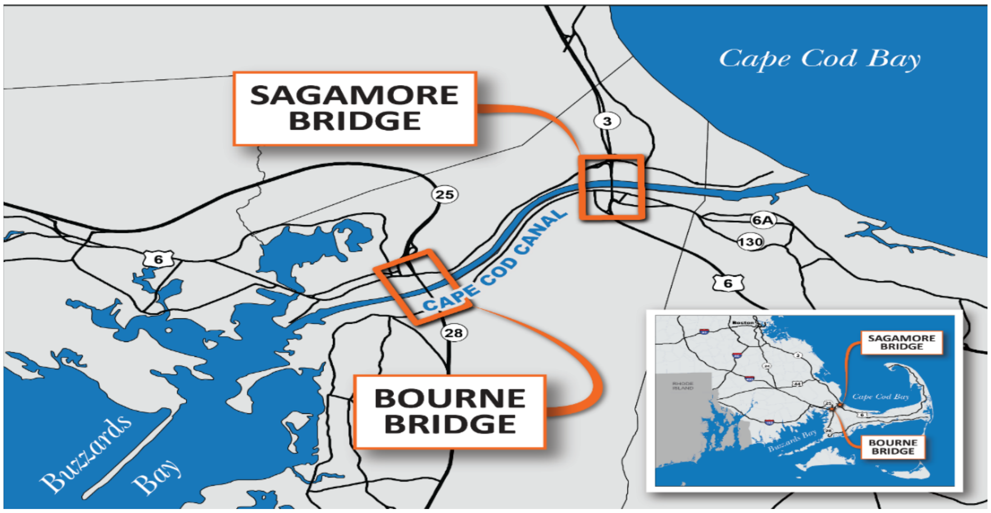
The upland portions are designated as tracts, with boundaries corresponding to the property lines of lots taken by condemnation in the 1930's for creation of the canal, as result the owner of title is the United States of America. The utility out-grant will only convey rights to cross the Cape Cod Canal, there are access rights existing, with short term termination declarations. Purpose: Permission to traverse across, over, under or within the Cape Cod Canal USACE property (utility easements and or license).

5) Project History

The proposed USACE out-grant (utility license/easement) crosses the Cape Cod Canal, which is adjoined by three small tracts of U.S. Government owned land (Cape Cod Canal District); identified on the exhibit on the succeeding pages. The referenced tracts of land support Canal operational requirements.

There is currently and existing Verizon/Comcast conduit for the operation of the telecommunication transmission, electric cables and gas lines over the Cape Cod, which has no adverse impact on the Canal operations.

SAGAMORE & BOURNE BRIDGES CAPE COD CANAL

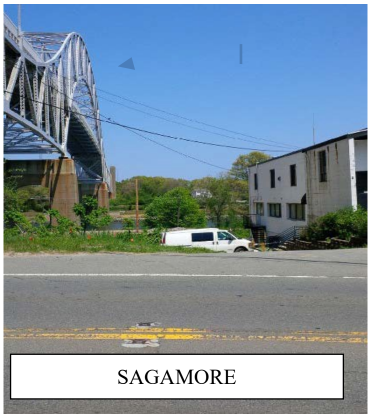


Area and Neighborhood Analysis

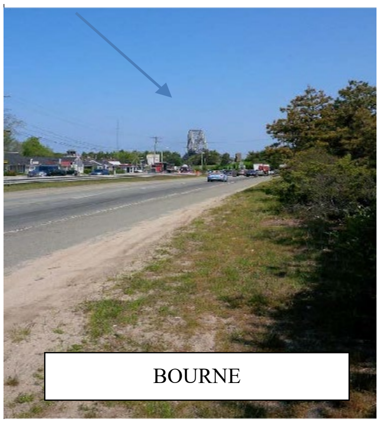
Massachusetts experienced significant growth during the late 1990's until both the National and regional economies faltered. A recent review of U.S. Bureau of Statistical data indicates a continued decline in manufacturing, with information sector services and professional services reporting nominal gains.

A) Neighborhood Description: Mixed uses within the neighborhood with a variety of property types, with the subject property typical and customary to the area, along the bridge positioning and road access**.**

B) Property Description: The property consists of a series of property along the defined areas described on the bridge replacement maps attached and indicated Parcels addressed. The subject property is considered free of any hazardous material or environmental stigma. The subject property is considered unimproved land with the photos representing the Sagamore Bridge in the first two captions below and the Bourne Bridge in the third caption, respectively, as shown below:


SAGAMORE

SAGAMORE


BOURNE

6) Estate owned / Estimated:

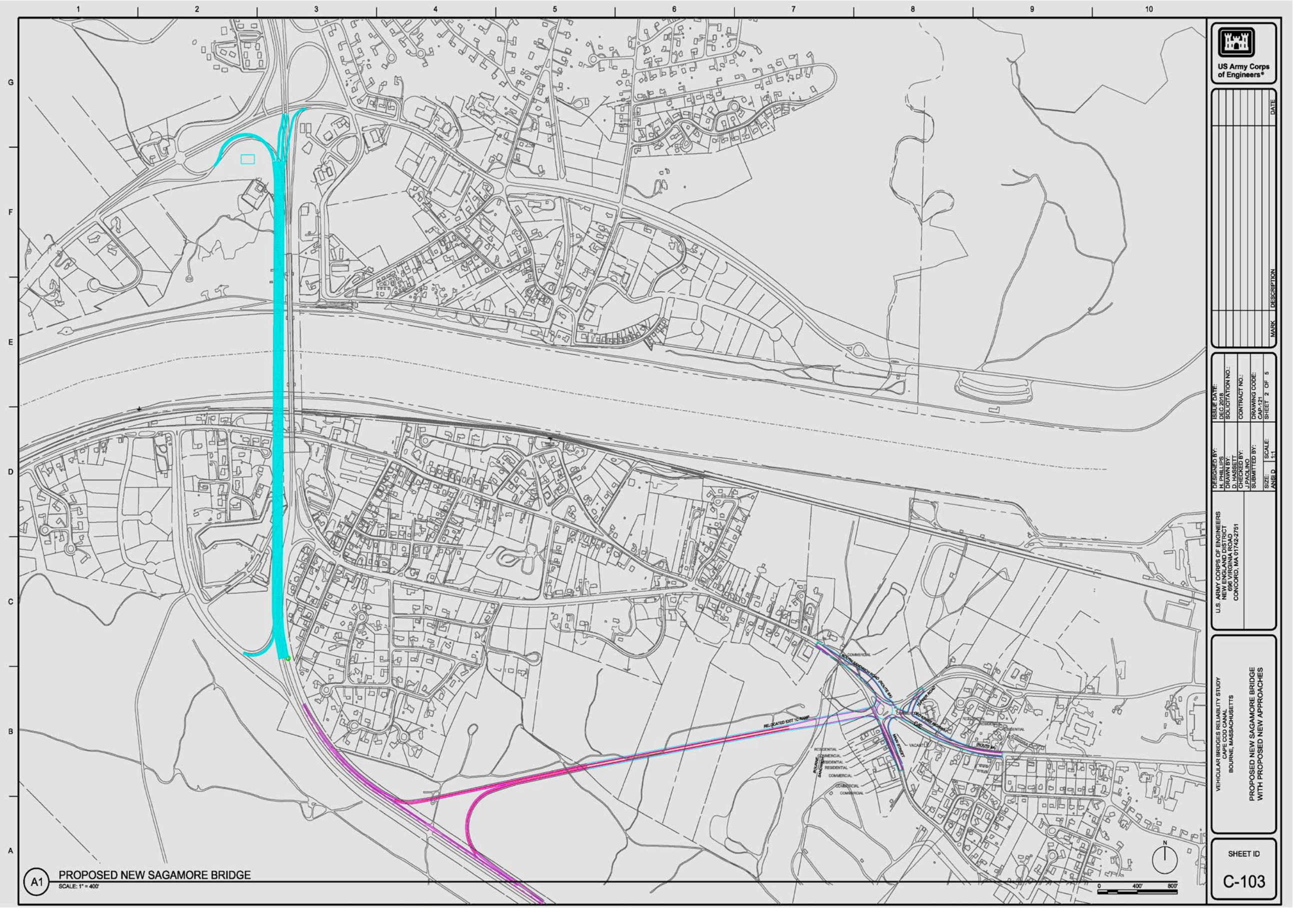
The estate being analyzed herein is the fee simple estate. The cost estimate assumes no encumbrances, hazardous or stigma considered with the various subject property, if acquired. Ancillary sites of government property is considered, which could change with alternative plans or more definitive engineering detail. The extended abutments added to the amount of government land requirements for approaches to the bridges. Private land detail would be based on actual site survey and construction design requirements.

The greatest impact is represented above with the first three pictures of the Market Basket retail plaza at the Sagamore Bridge and the Dunkin Donut site at the Bourne Bridge, both relocations were based on 25% of the real estate loss from the areas considered in the permanent easement line represented on the referenced map below.

7) Basis / Support for Cost Estimate of Subject Property

Comparable vacant land sales and listings in the neighborhood and general area, which represent similar uses and similar potential highest and best use indications. Information used is retained in Cost Estimate “CCC Bridges file”. The greatest impacts are the north side of the Bourne and the south side of the Sagamore on the Cape side of both bridge replacements. A Gross Appraisal at this time is considered premature and would be required at the time of completion of the Design Phase.

PROPOSED SAGAMORE BRIDGE PLAN

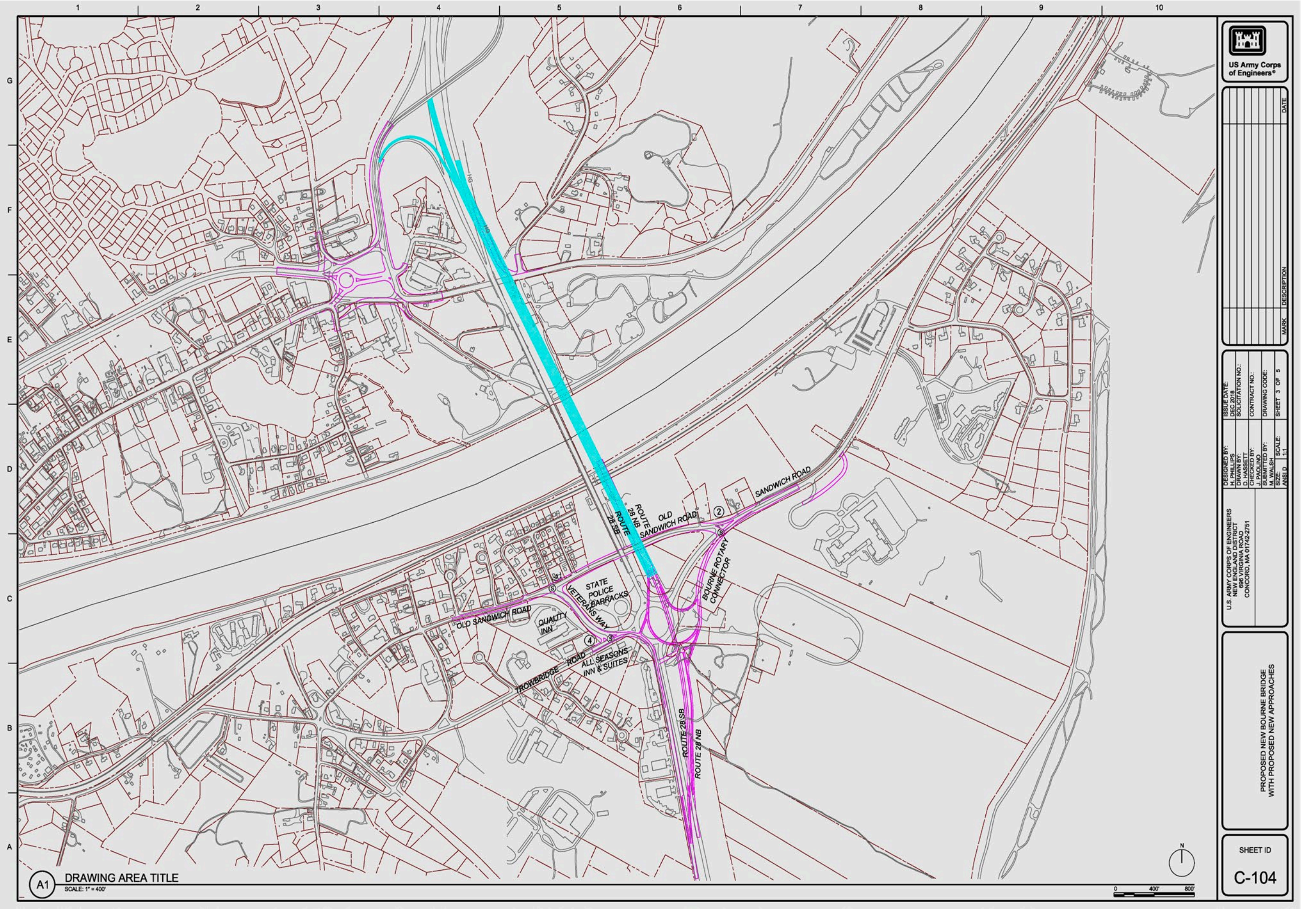


A1 PROPOSED NEW SAGAMORE BRIDGE
SCALE: 1" = 400'
US Army Corps of Engineers
U.S. ARMY CORPS OF ENGINEERS NEW ENGLAND DISTRICT 696 VIRGINIA ROAD CONCORD, MA 01742-2751
DESIGNED BY: H. PHILLIPS
DRAWN BY: D. HASSETT
CHECKED BY: J.PAOLINO
SUBMITTED BY:
SIZE: ANSI D
SCALE: 1:1
ISSUE DATE: DEC 2018
SOLICITATION NO.:
CONTRACT NO.:
DRAWING CODE: CAP-121
SHEET 2 OF 5
MARK
DESCRIPTION
DATE
VEHICULAR BRIDGES RELIABILITY STUDY CAPE COD CANAL BOURNE, MASSACHUSETTS
PROPOSED NEW SAGAMORE BRIDGE WITH PROPOSED NEW APPROACHES
SHEET ID
C-103

The subject property was estimated from unimproved sales in the Cape area from Loop net, Realtor.com, *CoreLogic* and the local Assessor and other sources.

The commercial sales ranged from $350,000/Ac to $650,000/Ac for similar land rea, suggesting the commercial land currently is at ±$500,000/Ac or ±$10/SF, for the unimproved commercial/retail land.

PROPOSED BOURNE BRIDGE PLAN



The improvements were viewed and there were no apparent encroachments into the improved areas. Having observed only vacant land other than the Market Basket (Sagamore) property and the Dunkin Donut (Bourne) sites.

8) Remarks or Additional Explanation:

No stigma hazardous material, or encumbrances considered for this estimate. The ±90% of the bundle of rights taken is based on current use and the unbalanced use of owner and easement holder. List described below is the current easement and License list for the two CCC Bridges

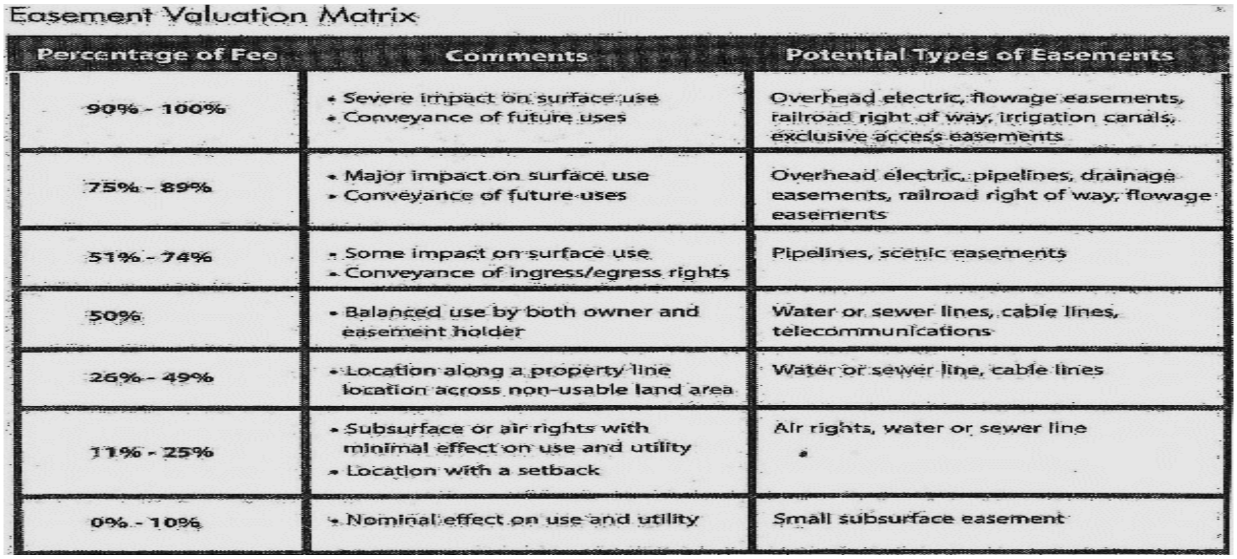
BOURNE BRIDGE	Grantee	Document No.	Expiration Date	Granted Purpose
	Canal Sportsman Club	DACW33-3-99016	6-Feb-19	water supply pipeline
	Colonial Gas	DACW33-2-20-003	4-Nov-24	gas pipe line
	Comcast	DACW33-3-19-008	30-Apr-23	fiber optic cables
	Algonquin Gas	DACW33-2-03-11	28-Apr-52	natural gas metering station
	Town of Bourne	DACW33-2-83-61	1-Jun-33	water supply pipeline
	NSTAR	DACW33-3-97-14	31-Oct-21	transmission of electricity
	Verizon	DACW33-2-08-066	30-Sep-28	Verizon Network Facilities
	MA DOT	DACW33-3-85-12	Expired	Easement not issued for drainage pipeline

SAGAMORE BRIDGE	Grantee	Document No.	Expiration Date	Granted Purpose
	Verizon	DACW33-2-08-065	30-Sep-28	Verion Network Facilities
	MA DOT	DACW33-2-16-003	28-Feb-20	drainage pipe
	Algonquin Gas	DACW33-2-95-12	31-May-25	gas pipe line
	Algonquin Gas	DACW33-2-71-43	31-May-21	rectifier & anode bed
	Algonquin Gas	DACW33-2-19-027	29-Apr-24	gas pipe line
	Colonial Gas	DACW33-2-19-001	29-Apr-24	gas pipe line
	Open Cape	DACW33-2-12-071	14-Jun-32	Verion sub-license - optic cables
	Colonial Gas	DACW33-1-96-59	14-Nov-24	subsurface electric transmission wires
	North Sagamore Water District	DACW33-2-79-129	23-Sep-29	water pipe line
	Comcast	DACW33-3-19-008	30-Apr-23	fiber optic cables

*Some outgrants are in the footprint of the MRER Survey Area Sagamore and Bourne Bridge

9) **The ±10% remaining value of the property is based on quiet enjoyment and buffer, which is limited.**

10) **Cost Estimate**
Land sales included both institutional and commercial. Several properties in Bourne were considered for commercial costs, mostly in Bourne and others in surrounding Cape Cod communities. There was no supporting evidence suggesting an increase or decrease in the prior cost estimate.



Easement Valuation Matrix

Percentage of Fee	Comments	Potential Types of Easements
90% - 100%	• Severe impact on surface use • Conveyance of future uses	Overhead electric, flowage easements, railroad right of way, irrigation canals, exclusive access easements
75% - 89%	• Major impact on surface use • Conveyance of future uses	Overhead electric, pipelines, drainage easements, railroad right of way, flowage easements
51% - 74%	• Some impact on surface use • Conveyance of ingress/egress rights	Pipelines, scenic easements
50%	• Balanced use by both owner and easement holder	Water or sewer lines, cable lines, telecommunications
26% - 49%	• Location along a property line location across non-usable land area	Water or sewer line, cable lines
11% - 25%	• Subsurface or air rights with minimal effect on use and utility • Location with a setback	Air rights, water or sewer line
0% - 10%	• Nominal effect on use and utility	Small subsurface easement

<table>
<tr><td colspan="2">Commercial/Retail land cost $500,000/Ac (based on ±90% interest = $450,000/Ac or ±$10.35/SF)</td></tr>
<tr><td colspan="2">Approximate Estimated Measurements of Private Land Area:</td></tr>
<tr><td>Permanent Bourne</td><td>Permanent Sagamore</td></tr>
<tr><td>479,160 SF (estimated) 11AC</td><td>196,020 SF (estimated) 4.5 AC</td></tr>
<tr><td colspan="2">Cost Analysis</td></tr>
<tr><td colspan="2">Areas of impact 100% institutional, commercial, industrial and retail influence</td></tr>
<tr><td colspan="2">Total Permanent Easement Cost</td></tr>
<tr><td>Bourne: 11 AC * $450,000 = $4,950,000.00 Plus improved site.</td><td>Sagamore: 4.5 AC * $450,000 = @2,025,000 Plus improved site</td></tr>
<tr><td>Physical Losses/ non consequential/non-incidental damages</td><td>Physical Losses/ non consequential/non-incidental damages</td></tr>
<tr><td>Improvements $1,000,000 (2000 SF small retail $500/sf</td><td>Improvements $4,500,000 ($15,000 SF large retail $300/SF</td></tr>
<tr><td>Business relocation 20% $1,000,000 Non-Compensable</td><td>Business relocation 20% $400,000 Non-Compensable</td></tr>
<tr><td colspan="2">Total Estimated Cost</td></tr>
<tr><td>Bourne: $5,950,000</td><td>Sagamore: $6,525,000</td></tr>
<tr><td colspan="2">Total Real Estate Damages including Non-Compensable (Consequential) Cost /Damages:
$13,875,000 Rounded Cost: $14,000,000</td></tr>
</table>

11) Conclusion:

The cost opinion of the subject property is based on file information and research based on a physical inspection. This report is classified as a Cost Estimate and not an appraisal, as requested during planning stages of the project, as of the 5th day of August 2019, update 15 January 2020 the estimate of $12,475,000, considered reasonable and supportable with a range of $12,000,000 to $14,000,000, including chattel and is evidenced by area land sales, within the market area of Bourne, MA Cape Cod Project--no Utility Relocation considered. All public land not considered compensable items for this analysis. The “Rough Order of Magnitude” is considered reasonable at this stage of conceptual design, with acreage estimated for an easement and acquisition estimate. There was no supporting evidence suggesting an increase or decrease in the prior cost estimate.

Total Real Estate Cost includes Acquisitions, Permanent and Temporary Easements:

Twelve Million Five Hundred Thousand Dollars ($12,500,000) rounded (Real Estate Cost Estimate does not consider Contingencies & Non-Compensable Items)

4.6.2.3. Non-Compensable (Consequential) Damages. *Because the compensability of a particular aspect of damage stems from its treatment in the open market between willing buyers and sellers, losses that are not reflected in sales prices in the private market cannot be considered in federal acquisitions. Applying this principle, federal courts have determined that the following losses are not compensable under the Fifth Amendment: loss of business value or going concern value;783 loss of or damage to goodwill;784 future loss of profits;785 frustration of plans;786 frustration of contract or contractual expectations;787 loss of opportunity or business prospect;788 frustration of an enterprise;789 loss of customers;790 expenses of moving removable fixtures and personal property;791 depreciation in value of furniture and removable equipment;792 increased production or management costs;793 damage to inventory or equipment;794 expense of adjusting or restructuring manufacturing operations;795 incurrence of removal or relocation costs;796 loss or cancellation of revocable permits or licenses;797 loss of ability to collect assessments;798 uncertainty premium due to tenant’s status as a government entity;799 and interference* with development.

785 *Id.*; *United States ex rel. Tenn. Valley Auth. v. Powelson,* 319 U.S. 266, 283 (1943); *Yuba Nat. Res., Inc. v. United States,* 904 F.2d 1577, 1581-82 (Fed. Cir. 1990); *Ga.-Pac. Corp. v. United States,* 640 F.2d 328, 360-61 (Ct. Cl. 1980) (per curiam).
786 *1735 N. Lynn St.*, 676 F. Supp. at 701 (citing *Powelson*, 319 U.S. at 281-82 & n.12, and *Omnia Commercial Co. v. United States*, 261 U.S. 502, 513 (1923)).
787 *Omnia*, 261 U.S. at 513; *United States v. 57.09 Acres of Land in Skamania Cty.* (*Peterson II*), 757 F.2d 1025, 1027 (9th Cir. 1985); *United States v. 677.50 Acres of Land*, 420 F.2d 1136, 1138-39 (10th Cir. 1970); *Hooten v. United States*, 405 F.2d 1167, 1168 (5th Cir. 1969); *United States v. 1.604 Acres of Land* (*Granby I*), 844 F. Supp. 2d 668, 681-82 (E.D. Va. 2011); *United States v. Gossler*, 60 F. Supp. 971, 976-77 (D. Or. 1945).
788 *Omnia*, 261 U.S. at 513; *United States v. Grand River Dam Auth.*, 363 U.S. 229, 236 (1960); *Powelson*, 319 U.S. at 283.
789 *Omnia*, 261 U.S. at 513; *Grand River*, 363 U.S. at 236.
790 *S. Ctys. Gas Co. of Cal. v. United States*, 157 F. Supp. 934, 935-36 (Ct. Cl. 1958), *cert. denied*, 358 U.S. 815 (1958); *R.J. Widen Co. v. United States*, 357 F.2d 988, 990, 993-94 (Ct. Cl. 1966); *see Stipe v. United States*, 337 F.2d 818, 819-21 & n.3 (10th Cir. 1964).
791 *United States v. Gen. Motors Corp.*, 323 U.S. 373, 378 (1945).
792 *Certain Land in City of Washington v. United States*, 355 F.2d 825, 826 (D.C. Cir. 1965); *see County of Ontonagon v. Land in Dickinson Cty.*, 902 F.2d 1568, 1990 WL 66813, *3-*4 (6th Cir. 1990) (unpubl.).

793 *PVM Redwood Co. v. United States*, 686 F.2d 1327, 1328-29 (9th Cir. 1982); *Ga.-Pac. Corp. v. United States*, 640 F.2d 328, 360 n.44, 363-65 (Ct. Cl. 1980) (per curiam).

794 *Klein v. United States*, 375 F.2d 825, 829 (Ct. Cl. 1967).

795 *United States v. 91.90 Acres of Land in Monroe Cty.* (*Cannon Dam*), 586 F.2d 79, 87-88 (8th Cir. 1978); *Klein*, 375 F.2d 825 at 829.

796 *United States v. Westinghouse Elec. & Mfg. Co.*, 339 U.S. 261, 264 (1950); *United States v. Petty Motor Co.*, 327 U.S. 372, 377-78 (1946); *Intertype Corp. v. Clark-Congress Corp.*, 240 F.2d 375 (7th Cir. 1957); *Ga.-Pac.*, 640 F.2d at 361 n.44. But see exception discussed below regarding temporary acquisitions that interrupt but do not terminate a longer term.

797 *Acton v. United States*, 401 F.2d 896, 897-900 (9th Cir. 1968); *United States v. Cox*, 190 F.2d 293, 295-96 (10th Cir. 1951); *see also* Section 4.11.2 (Federal Grazing Permits).

798 *United States v. 0.073 Acres of Land* (*Mariner's Cove*), 705 F.3d 540, 546-49 (5th Cir. 2013); *but see Adaman Mut. Water Co. v. United States*, 278 F.2d 842 (9th Cir. 1960) (regarding restrictive covenants for collection of assessments for water extracted from burdened properties).

799 *United States v. 131,675 Rentable Square Feet of Space* (*GSA-VA St. Louis I*), No. 4:14-cv-1077 (CEJ), 2015 WL 4430134, *4 (E.D. Mo. July 20, 2015); *see United States v. Gen. Motors Corp.*, 323 U.S. 373, 379-80 (1945); *United States ex rel. Tenn. Valley Auth. v. Powelson*, 319 U.S. 266, 276 (1943).

12) **The "Cost Estimate" is effective as of 15 January 2020**

There was no supporting evidence suggesting an increase or decrease in the prior cost estimate.

13) **The Subject Property:**

Consists of land along the approaches of both the Bourne and Sagamore bridges. Comparable vacant land sales and listings in the neighborhood and general area, which represent similar uses and similar potential highest and best use indicators were compared. Information used is retained in Cost Estimate file. The greatest impacts are the north side of the Bourne and the south side of the Sagamore on the Cape side of both bridge replacements.

14) **Cost Figures:**

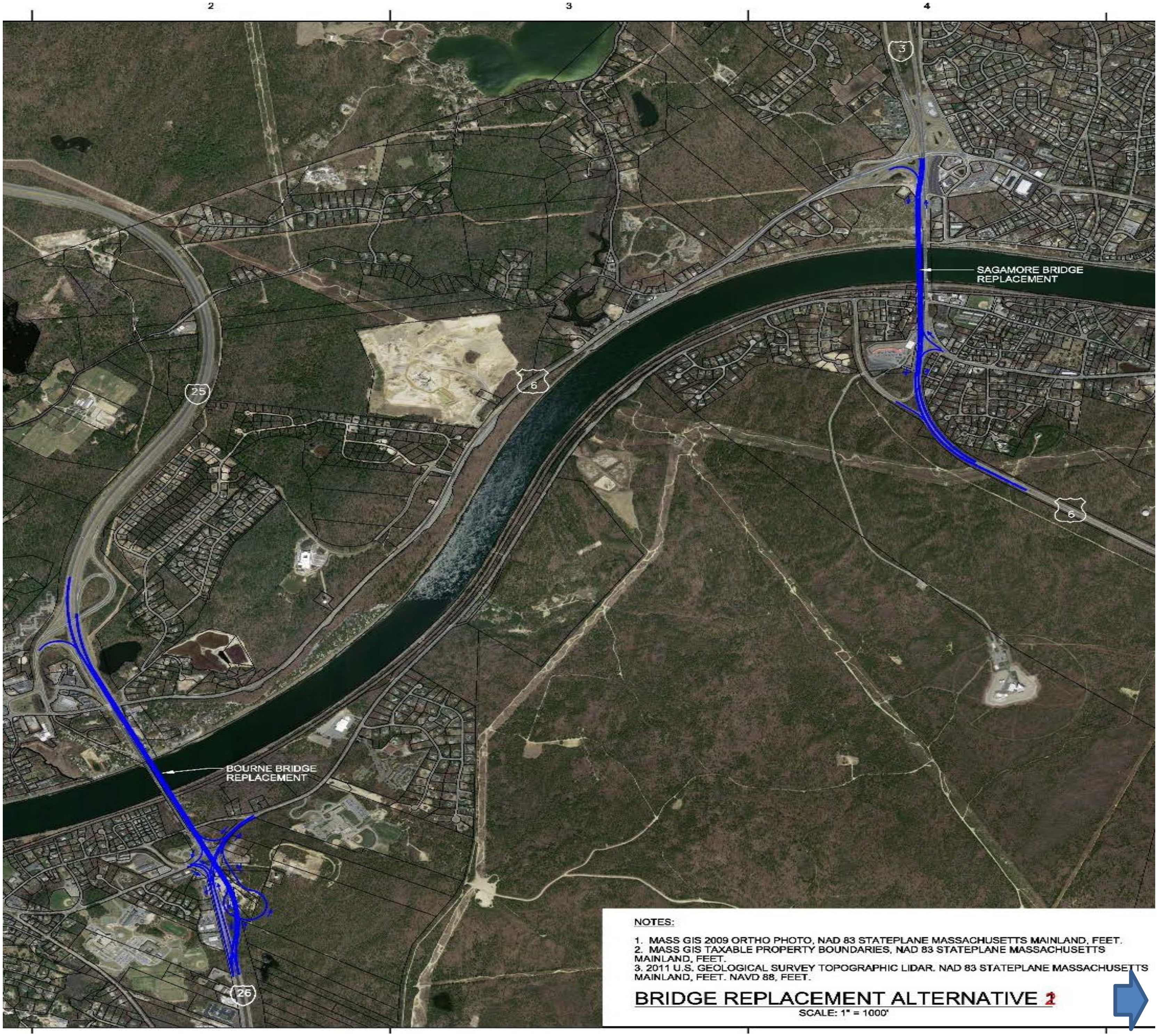
The cost figures are clear and based on acreage for the current stage of the project and preliminary plans, which suggests the best approaches to proposed entrances to the bridges and land costs. The Design Stage and Mass Dot approach plans would result in more Real Estate detail for Parcel delineation. The West side main land approaches involve municipal, State and Federal land all to be related to the project and regarded as donated public land for public use, with no anticipated land acquisition costs, subject to Mass Dot bridge approach/access detail. Prior to Bridge placement design detail Parcel delineation is premature and could be misleading at the stage of planning.

I certify that I have no personal interest, present or prospective in the property, or with the owners there of. The estimate reported represents my best, unbiased judgment. This cost report requires no additional certification and is subject to change, as alternatives are introduced or land areas calculated by engineering, adjusting the costs based on the limited construction design detail at the time of the estimate. The "Rough Order of Magnitude" is considered reasonable at this stage of conceptual design, with acreage estimated for an easement and acquisition estimate.

Daniel E. Jalbert, MAI, AI-GRS, ASA
District Review Appraiser
Department of the Army
United States Army
Corps of Engineers New
England District NAE
696 Virginia Road, Concord, MA 01742-2751
Desk Phone: 978-318-8322 | Fax: 978-318-8867
daniel.e.jalbert@usace.army.mil

Enclosures

ADDENDA



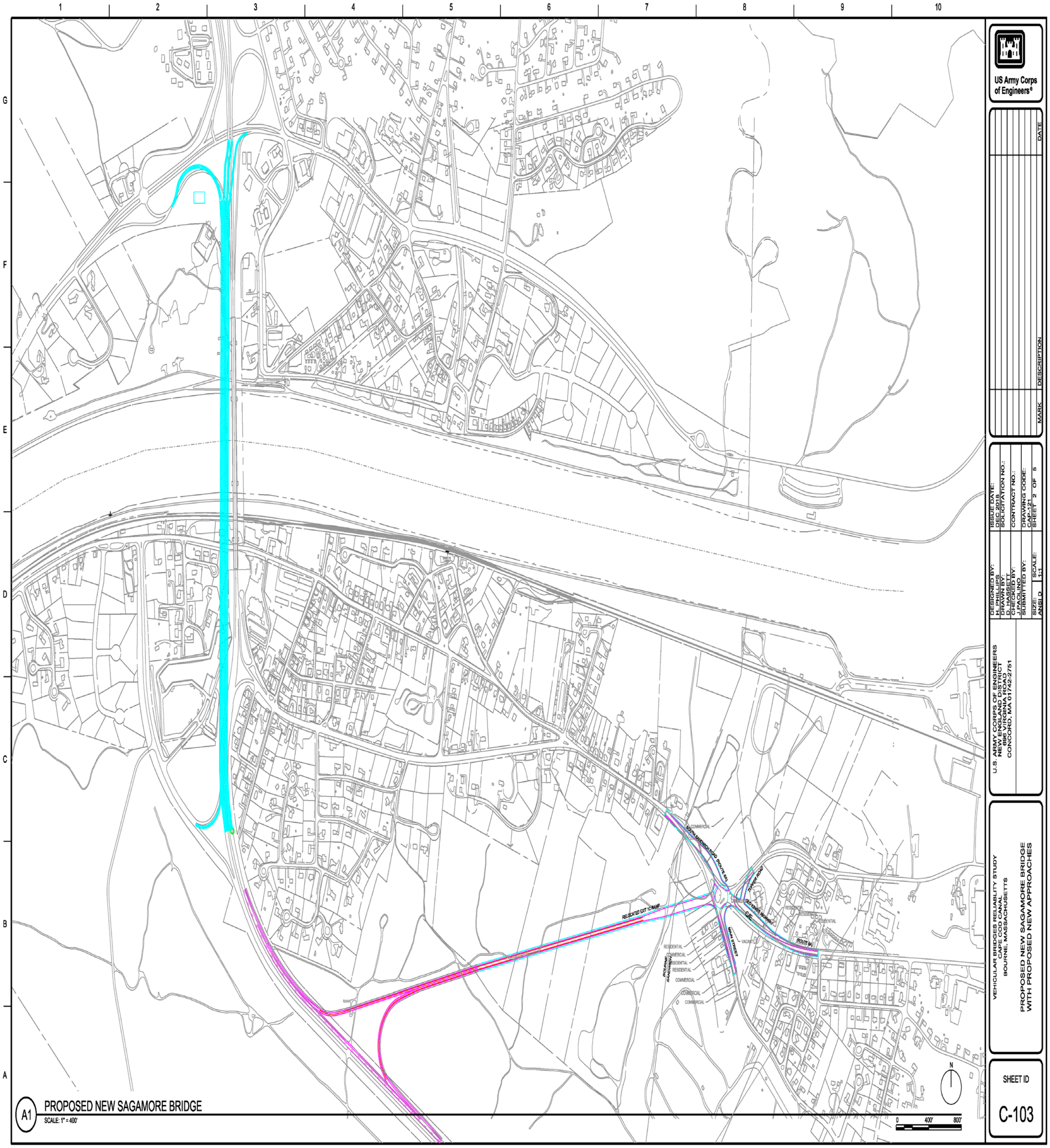
NOTES:

1. MASS GIS 2009 ORTHO PHOTO, NAD 83 STATEPLANE MASSACHUSETTS MAINLAND, FEET.
2. MASS GIS TAXABLE PROPERTY BOUNDARIES, NAD 83 STATEPLANE MASSACHUSETTS MAINLAND, FEET.
3. 2011 U.S. GEOLOGICAL SURVEY TOPOGRAPHIC LIDAR. NAD 83 STATEPLANE MASSACHUSETTS MAINLAND, FEET. NAVD 88, FEET.

BRIDGE REPLACEMENT ALTERNATIVE 2

SCALE: 1" = 1000'

PROPOSED BRIDGE IMPACT AREAS & PROVISIONAL APPROACHES TO THE SAGAMORE BRIDGE



BOURNE BRIDGE APPROACHES & IMPACT AREAS